GOOD PRACTICE GUIDE 307

Fuel Management Guide

ROAD HAULAGE MODERNISATION FUND RHMF

Fuel Economy Advisors

BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

BEST PRACTICE PROGRAMME

GOOD PRACTICE GUIDE 307

FOREWORD

This Guide contains information, advice and suggestions to improve the fuel performance of your vehicle fleet.

References to other Energy Efficiency Best Practice Programme (EEBPP) Guides will be found in the suggested programme of work in Section 1 of the Guide.

To obtain copies of EEBPP Guides, and for further information on any energy-related issue, including transport, you can contact the **Action Energy Helpline on 0800 585794**. All EEBPP Guides are free of charge, as is the Helpline.

Wherever possible and appropriate, **each section ends with a summary of action points**. Examples are either included in the text or in an appendix at the end of the section.

At the end of most sections, there is a simple checklist of key points covering the main subjects discussed. Included with this Guide is a disk containing spreadsheets to help you manage fuel data and some of the tables shown in the Guide. You can use these to adapt (if necessary), for maintaining electronic records and to print off to display or to distribute to staff.

This Guide is also available in electronic form from the Energy Efficiency Best Practice Programme web site: *www.energy-efficiency.gov.uk/transport*

From time to time, updates to the Guide will be posted on the site for you to review and download as you wish. Wherever possible, the sections are stand-alone, meaning that individual sections can be downloaded separately.

It is intended that further sections on specialist areas, such as aerodynamics, tyres, on-board computers, alternative fuels, maintenance, and fuel-saving devices, will be issued on the web site, so please look out for updates.

The Fuel Economy Advisors scheme will be delivering the advice provided in this Guide at local seminars throughout England. See the back cover for details on how to register for these free seminars.

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ENERGY EFFICIENCY

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- Shell UK Ltd
- Transport Engineer
- UK PIA
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In addition we would like to thank all the organisations that have allowed us to quote them in the case studies/examples included in this Guide.

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Contact details for the Fuel Economy Advisors Scheme

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The Government's Energy Efficiency Best Practice Programme provides impartial, authoritative information on energy efficiency techniques and technologies in industry, transport and buildings. The information is disseminated through publications, videos and software, together with seminars, workshops and other events. Publications within the Best Practice Programme are shown opposite.

For further information visit our web site at www.energy-efficiency.gov.uk or call the Action Energy Helpline on 0800 585794.

ENERGY EFFICIENCY

Fuel Economy Advisors

Energy Consumption Guides: compare energy use in specific processes, operations, plant and building types.

Good Practice: promotes proven energy efficient techniques through Guides and Case Studies.

New Practice: monitors first commercial applications of new energy efficiency measures.

Future Practice: reports on joint R & D ventures into new energy efficiency measures.

General Information: describes concepts and approaches yet to be fully established as good practice.

Fuel Efficiency Booklets: give detailed information on specific technologies and techniques.

Energy Efficiency in Buildings: helps new energy managers understand the use and costs of heating, lighting etc.

Printed on paper comprising 75% post-consumer waste and 25% elemental chlorine free pulp

INTRODUCTION

IMPROVING MPG BY 5% COULD SAVE YOU AS MUCH AS £1,000 PER VEHICLE

According to an EEBPP survey carried out in 1998, the average large goods vehicle (LGV) in the UK travels 130,000 km (80,000 miles) each year and uses diesel costing £20,000 (1998 figures). Most fleets that embark on fuel management programmes show savings of at least 5%, meaning an average saving of £1,000 per vehicle per year.

Recently, the price of fuel has risen faster than general inflation. If this continues, the value of fuel savings will increase still further.

Remember that the impact of making a five per cent saving in costs is usually magnified in its effect on profit eg

If current total costs	=	£500,000
then if fuel represents 30% of costs	=	£150,000
and current profit (at say 5%)	=	£25,000
then **5% saving** in fuel costs	=	£7,500
will **increase profit by 30%** to		£32,500

Some operators will already have implemented a fuel improvement programme to varying degrees. Early on, you should assess where you are, and target the level of savings you will be trying to achieve.

1.1 WHO IS THE GUIDE AIMED AT?

The guide is written for fleet operators with a variety of different levels of experience and knowledge.

If required, assistance in interpretation of the guidance is available from the Action Energy Helpline (0800 585794).

Using fuel more efficiently means:

- lower costs;
- improved profit margins;
- reduced emissions;
- improved environmental performance.

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1.2 SELF AUDIT

The following 'Self Audit' can be used to assess the status of fuel management in your organisation, and together with the suggested programme of work in the next section, can help you to identify the priorities for action and direct you to the right part of the Guide.

Section	SELF AUDIT:	Yes/No
3	**Does the management of the organisation understand the importance of fuel management?**	
	Do they know; - their fuel costs? - what percentage of operating costs they represent? - how these costs can be reduced?	
4	**The Fuel Champion and their action plan**	
	- Has a Fuel Champion been appointed and do they have the necessary authority?	
	- Is there a fuel management plan of action or programme in place?	
7	**How well are your fuel stocks managed? Do you review/have best practice in place for:**	
	- Ordering systems?	
	- Receiving bulk stocks?	
	- Controlling issues, stock movements and stock losses/gain?	
	- Are maintenance contracts in place for bulk fuel tanks, tank desludging, fuel pump calibration?	
8	**Does the organisation have good quality fuel performance information that is:**	
	- Accurate, timely and relevant?	
	- Well communicated throughout the organisation?	
	- Fed back to the drivers via notice boards, briefings etc?	
	- Used by management to help make decisions?	
	- Used by maintenance together with service records to help identify poor driving habits and poorly performing vehicles?	

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Section	SELF AUDIT:	Yes/No
9	**Are vehicles carefully specified taking into account:**	
	- Whole life costs?	
	- Optimising vehicles to the requirements of the job?	
	- Whether aerodynamic aids are appropriate?	
10	**Does maintenance of the vehicles take into account their fuel performance?**	
	Are fuel performance figures available to those carrying out the maintenance of the vehicle?	
	Is there a good balance between minimising maintenance costs and optimising fuel performance?	
	Do maintenance monitor the vehicle for bad driving habits and report them back to the operational department?	
11	**Are the drivers in the organisation well motivated on fuel performance issues:**	
	Does selection of new recruits include checking their knowledge and understanding of fuel-efficient driving techniques?	
	Does induction and general driver training include fuel efficient driving techniques?	
	Are driver disciplines well enforced, eg tank filling, daily checks, and have they been reviewed and updated to ensure they include fuel saving points?	

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1.3 SUGGESTED PROGRAMME OF WORK

The following is one approach to developing and implementing a practical fuel management programme. It is of course up to you whether you follow it or develop your own programme. Further assistance and EEBPP Guides can be obtained by ringing the Helpline on 0800 585794.

Stage	Action	Reference Material – Energy Efficiency Best Practice Programme
Gaining management commitment	Read Section 2 – Role of Management Read Section 3 – Financial Implications Nominate/appoint the Fuel Champion	GPG112 Monitoring and targeting in large companies * GPG251 Maintaining the momentum * FEB20 Energy efficiency in road transport GPCS398 Fuel champion saves equivalent of 50 trailer loads of carbon dioxide a year
Preparing the Fuel Champion Get the 'Team' on board Develop Action Plan	Read Section 4 – The Fuel Champion Read Section 5 – Monitoring and Targeting Read Section 6 – Factors affecting Fuel Consumption Find similar organisations to your own to network with Use Trade Organisations (FTA/RHA/SOE etc) Identify the key people in your organisation Get them on board	GPG84 Managing and motivating staff to save energy * GPG172 Marketing energy efficiency * GPG186 Developing an effective energy policy * GPG235 Managing people, managing energy * GPG213 Successful project management for energy efficiency *
Start data collection/analysis	Read Section 8 – Data Collection Estimate costs and savings	ECG76 Benchmarking vehicle utilisation (Key Performance Indicators) GPG112 Monitoring and targeting in large companies *
Fuel	Read Section 7 – Fuel Talk to pump hardware and software suppliers	
Vehicles	Read Section 9 – Vehicle Specification Read Section 10 – Vehicle Maintenance Talk to vehicle manufacturers	GPG308 Truck aerodynamic styling
Drivers	Read Section 11 – Driver Talk to vehicle manufacturers Talk to driver training organisations	GPCS311 Energy savings through improved driver training VI015 Video: Save It! - the road to fuel efficiency VI016 Video: Save It! - Champions of fuel
Communications	Read Section 11D – Communications	RHMF001 Fuel saving tips GPG213 Successful project management for energy efficiency *
Implement		GPG213 Successful project management for energy efficiency *
Review	Confirm costs and savings	GPG213 Successful project management for energy efficiency *

*Note: All EEBPP Guides are free. Those marked with an * are primarily aimed at energy management in buildings and industry, but the same principles apply to vehicles.*

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Other Fuel-Related Specialist Areas		
On-board computers	Talk to manufacturers See Appendix 2	GPCS342 Fuel management for transport operators GPG273 Computerised routing and scheduling for efficient logistics
Alternative Fuels	Talk to alternative fuel suppliers and Powershift Tel 0845 602 1425	
Aerodynamics	Talk to vehicle manufacturers and Advanced statistics	GPG308 Truck aerodynamic styling
Agency drivers		
Tyres		
Pumps & pump systems		
Route planning	Talk to software supplier	GPG273 Computerised routing and scheduling for efficient logistics
Testing fuel saving interventions		FCE Fuel consumption evaluation A new guide on fuel saving devices to be published in late 2002
Supply chain management		GPCS374 Efficient JIT supply chain management GPCS364 Energy savings from integrated logistics management

*Note: Those marked with an * are primarily aimed at energy management in buildings and industry, but the same principles apply to vehicles*

Further advice and information is being produced on an ongoing basis, for the latest information on any of the subjects please contact the Action Energy Helpline on 0800 585794.

Many of these Guides can be downloaded as PDFs from www.energy-efficiency.gov.uk/transport

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2.1 INTRODUCTION

When introducing a fuel management programme, you will almost certainly be changing some or all aspects of the culture of the organisation.

One of the main aims must be to develop the drivers and all those using company fuel so that they drive naturally and automatically in a fuel-efficient manner. So management must provide plenty of support and encouragement, making it clear that the organisation encourages safe and fuel-efficient driving as part of the company culture.

In turn, management must recognise that fuel costs and usage are manageable and respond to exactly the same techniques and disciplines as any other management issue. If the fuel management programme is seen as just the flavour of the month, it will quickly lose its impact. Instead, it must become a permanent commitment - the benefits are always there and will accrue to everyone. It is good for the business, good for the environment and good for the drivers.

The driver is invariably the key that unlocks any transport operation's true saving potential. A major part of the manager's job in the fuel management programme therefore has to be driver-orientated.

2.2 SENIOR MANAGEMENT ISSUES

2.2.1 Commitment

Implementing a fuel management programme may require senior management to make a clear and public decision giving practical fuel management the priority and commitment it requires.

Section 3 uses a simple model to demonstrate the costs and benefits that are involved in fuel management. Use this model to calculate the costs and benefits yourself to provide some financial justification that the target is worth achieving.

Once you are convinced that it makes sense, the backing for a fuel management programme should ideally come from many parts of the business, including the board. If you are unionised, make sure the trade union feels involved in the programme.

2.2.2 Responsible person - the Fuel Champion

Early in the process a responsible person or 'Fuel Champion' should be appointed to lead the programme. This ensures there is always a focal point and that somebody is responsible for tracking progress and guiding the way forward, especially when other business pressures take the attention of management, even temporarily, away from fuel management.

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2.2.3 Approve and publicise the action plan

Development of the fuel management programme and its associated action plan is covered in Section 4.

Senior management will obviously want to approve the programme and its action plan, and having committed to it, must then play their part in communicating the programme upwards, downwards and sideways. That means to all levels of management and other departments as well as trade unions and drivers. The objective is to get everyone to buy into the programme so that it is not wrongly interpreted as just another pressure on drivers and other staff.

2.2.4 Demonstrate commitment

Success is more likely when drivers and those involved feel that the whole organisation is committed to fuel efficiency in everything it does. So seek out other instances of good energy use elsewhere in the organisation and use them as examples.

This is particularly valuable if senior management and directors are directly involved. A half-day economy driving course for senior management company car drivers would send out a powerful message as well as paying for itself in fuel savings.

2.2.5 Include company cars and their drivers in your programme

Another way of demonstrating real company-wide commitment could be to set up a fuel performance league table for company cars. There is an example in the Appendix at the end of this section.

Make fuel efficiency a criterion in selecting company cars. If management is given a choice of car, encourage them to select fuel-efficient vehicles, then monitor the results both of the vehicles and the drivers.

To help demonstrate management commitment, why not set up a company car drivers' league?

2.2.6 Link to other 'green' initiatives

Most organisations will want to demonstrate that they care about the environment. Many will have environmental policies in existence already. The fuel management programme can be linked directly to that programme, since one obvious effect of reducing fuel consumption is to reduce the amount of harmful emissions.

'Motorvate', set up in 2000, is a Government-backed award scheme designed to help companies cut their fleet costs and at the same time help the environment.

Although initially aimed at car and van fleets, heavy goods vehicle fleets are welcome to participate. Further details are available from the Motorvate Helpline 0808 100 9100 or visit the web site at www.greenerfleet.org.uk

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2.2.7 Discuss progress and support fuel-related initiatives

Talk regularly to drivers and management about their progress, and support transport managers in any initiative they take to improve fuel performance. The clear indication that fuel management is important to senior management will help to encourage everyone in the organisation to do their part.

2.2.8 Monitoring and Targeting

The basic principles of Monitoring and Targeting are described in Section 5, which explains the significance and importance of knowing what fuel performance currently is, and then understanding what performance **should** or **could** be.

It is worth taking time to review which Key Performance Indicators (KPIs) are most appropriate for the organisation - these need to be reviewed regularly to ensure that they do not become counterproductive. (See the case study for an example.) Once the KPIs have been set up, reporting systems which mirror the needs of the organisation can be introduced to ensure that the appropriate people are getting the right amount of information and the right content (see Sections 7 and 8 for some ideas).

CASE STUDY

ARE KPIs ACHIEVING THE RIGHT OBJECTIVE?

A company operating a 'bus-stop' type delivery service, judged its performance on miles per gallon achieved by each depot.

Whilst this worked well in most depots and on most routes, on some routes this was counterproductive. For example, for some trips, there were two possible routes:

- A motorway route, which was much longer, but resulted in a good mpg.
- A more direct route, which was shorter, but resulted in a poorer mpg.

When the routes were analysed, it was found that, despite the mpg being worse, the shorter more direct route actually used less fuel.

Finally, celebrate success. Give credit and encouragement whenever you can.

APPENDIX 2.A COMPANY CAR DRIVER LEAGUE TABLE

Company car driver league table – May 2002

Position	Name	Distance (kms)	Variance against target mpg (%)
1st	J Brown	2,911	28.1
2nd	F Smith	353	9.2
3rd	P Stevens	304	1.5
4th	R Williams	1,006	-6.9
5th	J North	460	-15.9

Company cars are usually part of a remuneration package and so can be a sensitive issue. The key point is to bring home to all people that everyone's fuel usage can and should be managed.

It is therefore recommended that fuel performance relative to an agreed 'baseline' for each vehicle be used, rather than the absolute consumption figure, due to the huge variance in car fuel performance.

Creating a baseline is in itself a sensitive issue - individual historical performance could be used to take into account regional, vehicle and driver variances.

In this particular example, a target mpg has been calculated for each driver based on his/her performance over the previous six months (seasonal variances have been ignored). The difference between the actual performance for each month achieved by each driver and his/her individual target is divided by the target and the result expressed as a percentage ie:

$$\text{\% variance against target mpg} = \left(\frac{\text{Actual mpg - target mpg}}{\text{Target mpg}}\right) \times 100$$

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Checklist

Section	*Things to do*	*In place*	*Done*	*Not appropriate*
2.2.1	Get the backing of the board	☐	☐	☐
2.2.1	Allocate resources and give fuel management high priority	☐	☐	☐
2.2.2	Appoint responsible person/Fuel Champion	☐	☐	☐
2.2.3	Approve the action plan	☐	☐	☐
2.2.3	Communicate	☐	☐	☐
2.2.4	Demonstrate commitment to the programme	☐	☐	☐
2.2.5	Consider setting up car driver league for company cars	☐	☐	☐
2.2.6	Link to other green initiatives	☐	☐	☐
2.2.6	Consider participating in the Motorvate scheme	☐	☐	☐
2.2.7	Talk regularly to management and drivers about progress	☐	☐	☐
2.2.7	Support transport managers	☐	☐	☐
2.2.8	Set up reporting systems and Key Performance Indicators	☐	☐	☐
2.2.8	Monitor progress closely and report to board	☐	☐	☐

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3.1 INTRODUCTION

This section looks at the financial implications of improving your fuel management and provides a model to help develop cost justifications and financial targets for your programme.

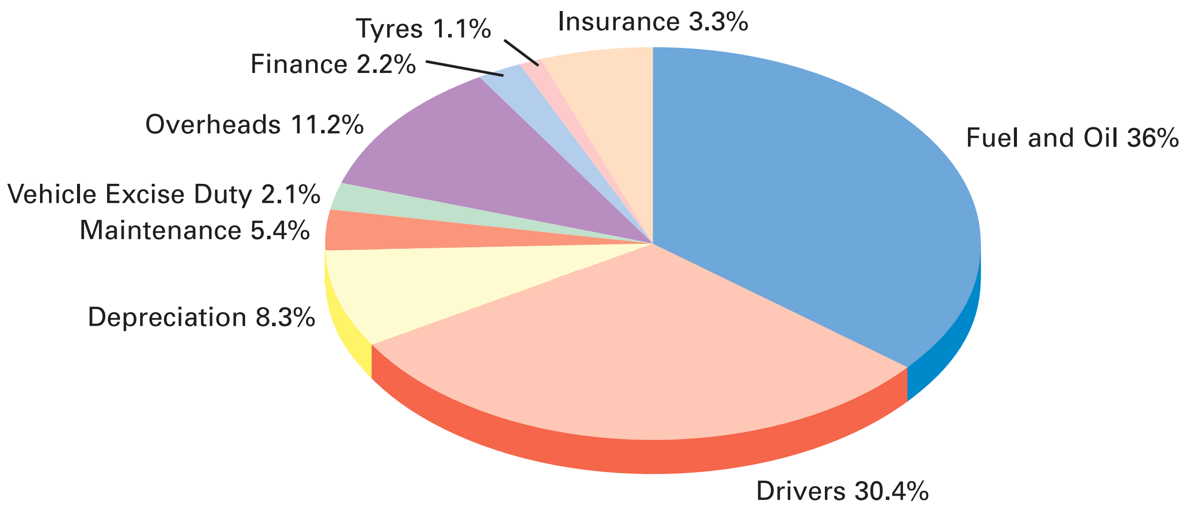
Although there are slight variations because of geographical location and the quantity purchased, transport operators pay broadly similar prices for fuel purchased in the UK. So better fuel management will lead to increased competitiveness with other companies and improved financial performance.

Remember that a small improvement in fuel usage can generate a much larger improvement in profitability as described in the Introduction.

3.2 UNDERSTANDING YOUR CURRENT COSTS

Before you can calculate the potential benefits of better fuel management, you must understand your current costs. Trade magazines regularly publish cost tables giving you typical cost breakdowns. Ideally, you should use your own cost figures, but if you are unsure of them, the published ones can be useful models.

Fig 3.1 shows the breakdown of the annual operating costs of a typical 40-tonne articulated vehicle covering 160,000 km a year.



The diagram is based on the figures contained in the review of operating costs published in January 2002 in *Transport Engineer*, the journal of the Institute of Road Transport Engineers, now one of the two professional sectors within the Society of Operational Engineers (SOE). Although no two operators have identical operating costs, these figures are representative and show how the various elements combine to make up the total.

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Table 3.1 shows the calculation in detail, and shows the various elements which need to be considered in calculating the costs of a vehicle.

Table 3.1 Typical cost of operating a 38-tonne gcw 4x2 tractive unit and two tri-axle curtain-sided trailers (January 2002)

The two-axle tractive unit averages 8.4 mpg and covers 120,000 km a year. The two tri-axle trailers each cover 60,000 km a year. Fuel cost is 58.8p per litre (January 2002 prices).

	Tractor	Trailer 1	Trailer 2	Total
Capital cost (£)	44,000	16,100	16,100	80,200
Annual distance (km)	120,000	60,000	60,000	
Ownership period (yrs)	5	10	10	
Fuel consumption (mpg)	8.4			
Standing costs				
Overheads (£)	9,487			9,487
Vehicle excise duty (£)	1,200			1,200
Insurance (£)	2,923			2,923
Depreciation (£)	7,100	1,280	1,280	9,660
Finance (over 5 years) (£)	1,936	708	708	3,352
Drivers (£)	27,047			27,047
Standing costs per year (£)	49,693	1,988	1,988	53,669
Standing costs per km (p)	41.4	3.3	3.3	44.7
Running costs				
Fuel and oil (£)	23,761			23,761
Tyres (£)	839	706	706	2,251
Maintenance (£)	4,098	1,219	1,219	6,536
Running costs per year (£)	28,698	1,925	1,925	32,548
Running costs per km (£)	23.9	3.2	3.2	27.1
Total costs per year (£)	78,391	3,913	3,913	86,217
Total costs per km (p)	65.3	6.5	6.5	71.9

Transport Engineer's figures indicate that fuel and oil account for 28% of a large truck's total operating costs, roughly the same as the driver costs. Other published cost tables (which may include only one trailer or assume a higher diesel price) put the proportion at closer to 33% with the Road Haulage Association survey of 2000 suggesting fuel as 42% of running costs.

For smaller and lighter vehicles that are more economical and usually cover less annual mileage, the fuel cost proportion is lower, typically around 20-25%.

Source: Transport Engineer

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3.3 PRICE OF FUEL

It is impossible to forecast crude oil prices accurately because there are so many unpredictable factors at work. These include political instability, the level of world demand, and policy decisions on production volumes by the major oil-producing countries,

In 2001, the price of diesel actually reduced by some 6%, against the previous seven years steady rise peaking at around 70 p/litre (for full tanker load deliveries). In real terms, three-quarters of the reduction was delivered by the fuel duty cut in the March 2001 budget. Recent events has seen an increase in the price of crude oil and consequently the price paid for diesel.

The combination of the crude oil price and fuel excise duty has meant that fuel has generally proved to be a fast-rising operating cost. This means that any investment in good fuel management now may well pay even greater dividends in the future. And those dividends drop straight down to the bottom line.

Are you delivering results? The acid test of any sound business-driven fuel management programme has to be clear evidence of financial savings once all the costs and benefits have been considered.

3.4 JUSTIFYING THE INVESTMENT

The achievement of fuel savings invariably requires an investment in time, effort or money - and often all three. Financial expenditure on such things as fuel monitoring equipment or better vehicles is easy to quantify, but do not forget hidden costs, such as investment in management, clerical and operative time, which may be more difficult to pin down.

If the fuel management programme has the effect of changing priorities, there may be a detrimental effect on another aspect of the business. In short, remember to consider the hidden costs as well as the obvious ones when calculating whether a fuel savings programme can be justified in terms of costs and payback. Doing this will help you establish targets and prove viability.

One simple approach to evaluating the costs and benefits is the ‘payback’ method, which looks at the costs and the time taken to generate savings to cover those costs. The case study shows a simple example.

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This is a very simple method which ignores factors such as inflation, cashflow, interest charges, changes in stock levels etc. Although it lacks detail and precision, it is a quick and easy way of assessing the broad viability of the project. Some companies are prepared to accept a longer payback period than others; a two-year period is often quoted as a rule of thumb to decide whether the project is viable.

CASE STUDY

Example of the use of Payback Period

A company decided to invest in aerodynamic equipment for one of its articulated vehicles. The capital cost per vehicle involved was £1,100 and the fuel used by the vehicle cost £50,000 per year. Tests showed an average saving of 3% on fuel through using the aerodynamic equipment.

Investment:

- Equipment £ 1,100 including fitting

Estimated fuel savings: **£ 1,500 per year**

Pay back period £1,100 / £1,500 per year = 9 months approximately

It is beyond the scope of this Guide to look at more complex ways of evaluating projects, such as the use of discounted cash flows. These sophisticated financial techniques are more applicable if the financial investment is particularly large or the payback period is potentially quite long. An Energy Efficiency Best Practice Programme Guide *Investment Appraisal for Industrial Energy Efficiency* (GPG69), available free of charge from the Helpline, gives some further guidance on this subject. However you will probably need to take advice from an accountant.

3.5 FINANCIAL MONITORING

Having set out to reduce future costs, it is essential to measure ongoing performance accurately. This will confirm that the investment in the fuel programme is paying off and that your expectations are being met. It will quickly show if targets are not being met and allow you to check the figures, revise the targets or maybe even suspend or increase expenditure on the programme.

The measurement of fuel efficiency should be part of the financial controls of any transport operation. This can be achieved through comparing actual costs with budget or standard costs in the same way that any other expenses are controlled. Variances between actual and budgeted expenditure can then be investigated and action taken quickly.

On the next page is an example of this important 'actual versus budget' check, showing how to resolve fuel cost variations that arise through a change in the mileage covered as well as a change in fuel performance.

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EXAMPLE

Calculating Fuel Costs

A company operating a fleet of rigids budgeted for vehicles to perform at 14.5 mpg and to travel 10,000 km per 4 week period. Diesel for the vehicles cost 65 pence per litre.

In fact, on average, the vehicles actually travelled 10,800 km (due to additional work) at 15.25 mpg following a programme of driver training.

The fuel cost of vehicle = miles divided by mpg multiplied by £ per gallon

	Budget	Actual	Variance
Distance travelled	10,000 kms	10,800 kms	800 kms
Multiply by 0.6214 to convert to miles	6,214 miles	6,711 miles	497 miles
mpg	14.5 mpg	15.25 mpg	0.75 mpg
Fuel cost	65 p/litre	65 p/litre	
Multiply by 4.546 to convert to £ per gallon	£2.95 per gall	£2.95 per gall	

Comparing budgeted cost with actual cost:

Budget Cost	=	6,214 miles ÷ 14.5 mpg x £2.95 per gall	=	£1,264.23
Actual Cost	=	6,711 miles ÷ 15.25 mpg x £2.95 per gall	=	£1,298.19
		Extra costs above budget	**=**	**£ 33.96**

Looking only at the costs, it would appear that there has been an increase. However, it is necessary to split out the effect of the increased distance travelled first. One way to do this is to compare budget with actual costs using actual distance travelled in both cases:

Budget Cost	=	6,711 miles ÷ 14.5 mpg x £2.95 per gall	=	£1,365.34
Actual Cost	=	6,711 miles ÷ 15.25 mpg x £2.95 per gall	=	£1,298.19
		Saving from improved mpg	**=**	**£ 67.15**

(Calculating the effect can be done in several ways. The conversion factors used in this example are taken from the list in Appendix 1 - Fuel Measurement and Conversion Factors.)

In this example, therefore, although total fuel costs have risen by nearly £34 per vehicle per month, the increased mileage travelled would have cost an additional £101.11 (£1,365.34 - £1,264.23), had it not been for the improvement in fuel consumption.

As a result of the improved mpg, there has in fact been a saving of £67 per vehicle per month.

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3.6 INDIRECT BENEFITS

It is generally accepted that driving in a fuel-efficient manner can improve safety and benefit the vehicle's driveline, brakes and tyres as well. So there could well be a reduction in the costs of accidents, maintenance, repairs and downtime.

Your insurance company may be prepared to discount the insurance premium if it has evidence of a driver-training programme, so it is worth checking with the insurer first to see if it has an agreement with a particular training provider. It could be sensible to specify a driver training course that specifically combines fuel economy with defensive driving.

Some operators have even used the improvement in fuel economy as a commercial tool to emphasise the contribution they are making to the environment (see - *Energy Savings Through Improved Driver Training* (GPCS311)).

Driver training that can encompass both fuel-efficient driving and defensive driving is likely to produce some useful results.

Thorough communication between drivers and management is part of a good fuel programme. If handled well, there is a potential spin-off here, because it might lead to better understanding and some barriers being broken down. Some organisations have used fuel efficiency as a means of changing the driver culture.

3.7 CONCLUSION

It remains to be seen whether the historical trend of fuel costs rising at least in line with inflation continues into the future. In times when consumer prices are static or even declining, there may be pressure on transport operators to reduce their rates instead of increasing them to cover any increase in fuel costs. This only serves to make the principle of fuel efficiency even more important.

Equally important is the need for reality to live up to the principle. This means monitoring actual performance against operational standards, and using strict financial measures that account for all the costs and benefits. Actual figures must always take precedence over theory, ambition and enthusiasm.

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Checklist

Section	*Things to do*	*In place*	*Done*	*Not appropriate*
3.2	Understand your current costs and how much you spend on fuel	☐	☐	☐
3.4	Identify potential savings of the programme	☐	☐	☐
3.4	Identify potential costs including hidden costs of the programme	☐	☐	☐
3.4	Evaluate the financial viability of the programme	☐	☐	☐
3.5	Monitor costs/benefits before, during and after the programme	☐	☐	☐
3.6	Look for indirect benefits - insurance, maintenance etc	☐	☐	☐
3.6	Look for the commercial benefits from fuel management	☐	☐	☐

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4.1 INTRODUCTION

The Fuel Champion is an important part of successfully managing your fuel performance. They must have sufficient authority and responsibility to ensure that the programme is successfully implemented.

If you do not wish to appoint a formal Fuel Champion, you must ensure that the programme has sufficient impetus to be successful despite the absence of a single focal point. This will be much more difficult to ensure.

The video *Save it! - Champions of Fuel* (VI016), available free of charge through the Helpline explains why there is a need for a “Fuel Champion” in small and large fleets.

4.2 ROLES AND RESPONSIBILITIES

The Fuel Champion will be required to drive the programme and, among other things, will need to develop the plan, resource it and ensure it is properly implemented.

Even when other business priorities divert senior managers’ attention, the Fuel Champion will ensure that the business never loses sight of the programme’s objectives. This will inevitably involve balancing conflicting interests, such as operational needs and driver training.

The Fuel Champion is responsible for fuel performance figures being produced, and communicating them to the appropriate people. He or she will make sure that any data or information circulated is relevant, correct, accurate and easily understandable by people who are not experts in the subject.

Depending on the size of the fleet, the Fuel Champion may be required to spend a significant amount of time on the project if it is to be successful. On the other hand, the financial benefits which can accrue from a well organised and implemented fuel management programme should make it a very worthwhile use of management time and energy.

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5.1 INTRODUCTION

Not all energy conservation measures are equally cost-effective. Different measures will be better suited to different types of operation. It is, therefore, important that anyone wishing to reduce their fuel consumption should proceed in a systematic manner, rather than introduce new practices on a piecemeal basis.

A simple set of principles has evolved from previous work in the field of energy conservation, collectively known as 'Monitoring and Targeting', or 'M&T'. By adopting M&T practices, organisations are able to identify problems and anomalies systematically.

The following is a simple explanation, which aims to give you an appreciation of the subject. It is recommended that you read up on this subject further – the Energy Efficieny Best Practice Programme Guide *Fuel champion saves equivalent of 50 trailer loads of carbon dioxide a year* (GPCS398) is a good starting place and is available free of charge from the Helpline.

5.2 MONITORING

There are five key elements in monitoring:

1 *Measure consumption regularly*

This will generally involve the production of regular (preferably weekly) records of the fuel consumption of each vehicle.

2 *Relate consumption to output*

Normally the distance travelled by the vehicle is related to the fuel used (eg miles per gallon), but this can be further refined. Other measures include fuel per tonne mile (ie fuel used to carry one tonne of payload a distance of one mile).

3 *Identifying present standards*

Analyse fuel consumption figures for similar vehicles undertaking similar types of work over a representative period of time. Arrive at an approximate fuel consumption standard for each vehicle. This would not constitute an 'efficient' standard but rather a base or actual figure.

4 *Report performance to individuals responsible*

Fuel consumption data should be reported regularly to people who have some influence on fuel consumption. These would normally include drivers, engineers and middle and senior management.

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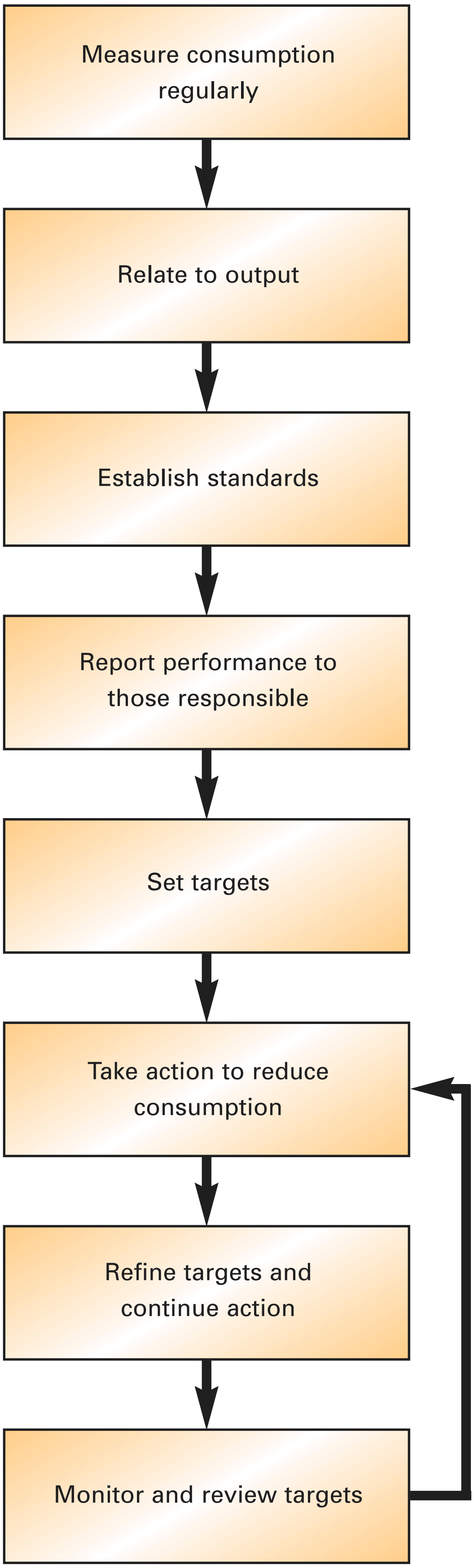

Fig 5.1 Stages of Monitoring and Targeting

5 Take action to reduce consumption

Taking a systematic overview of fuel use often generates ideas for reducing consumption. Comparing the fuel efficiencies of different vehicles is likely to reveal anomalies in their performance. Identifying the causes of these anomalies should enable good practice to be distinguished from bad, and allow steps to be taken to eliminate poor performance.

As good practice is applied more consistently, it may be necessary to revise the original standards that were set. Eventually it should be possible to establish a set of standards that accurately reflect the expected high levels of vehicle maintenance, driver behaviour and fleet management.

Tightening-up operating practices and vehicle maintenance in this way often leads to savings even without the introduction of specific fuel-saving measures.

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5.3 TARGETING

Targeting involves:

- setting goals for the reduction of fuel consumption;
- introducing specific measures designed to achieve these goals;
- reviewing progress and feedback;
- repeating the process in response to what has happened so far.

Fuel consumption should be related to a meaningful measure of output.

Frequently this will involve capital expense and/or significant changes to operating practices. These are best left until a good deal of data has been collected on the historical performance of the operation, so that the actions chosen are the most appropriate to the particular circumstances.

For example, targets could be set by measuring the actual performances of the best drivers on certain vehicles/routes etc. If any vehicles in the fleet are fitted with on-board computers connected to fuel flow meters, they can be used to help in setting these targets.

5.4 APPLICATION OF MONITORING AND TARGETING

The general principles of Monitoring and Targeting are transferable across many industries and circumstances. The process is simple in principle but can become very involved in practice eg taking into account variance in road conditions, weather conditions, type of road, traffic, load etc.

It is therefore recommended that you keep it simple initially, and develop the more complex processes over a period of time.

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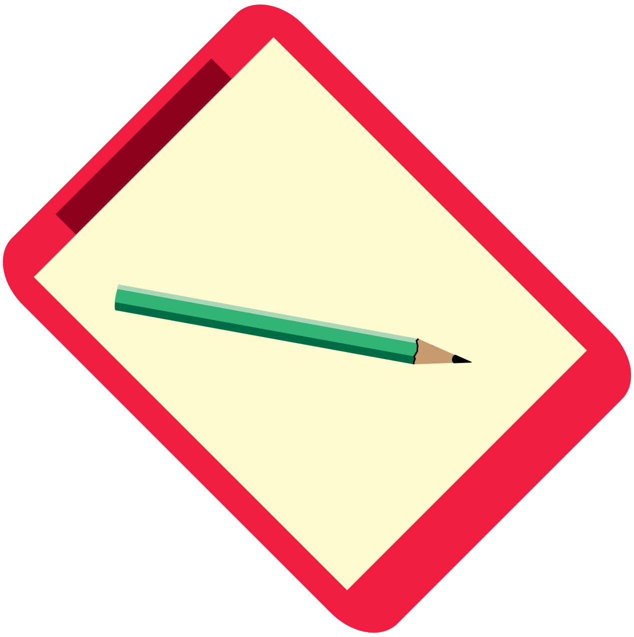
Checklist



Section	*Things to do*	*In place*	*Done*	*Not appropriate*
5.2	Understand what is meant by Monitoring and Targeting	☐	☐	☐
5.2	Compare with existing monitoring systems and identify any weaknesses	☐	☐	☐
5.2	Develop simple M&T systems for yourself	☐	☐	☐
8.7	Ensure Key Performance Indicators (KPIs) are appropriate and review their relevance regularly	☐	☐	☐
5.3	Consider use of on-board computers to help in setting targets	☐	☐	☐

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6.1 INTRODUCTION

Some of the factors that influence fuel consumption - such as the weather - are outside our control, but it is helpful to understand their effects. Other factors in the list below - such as routing and scheduling - can be managed by our own choices and decisions, and will be discussed in Section 6.6.

6.2 THE VEHICLE

The vehicle is obviously one of the largest factors in determining the fuel performance. The following areas have to be taken into account:

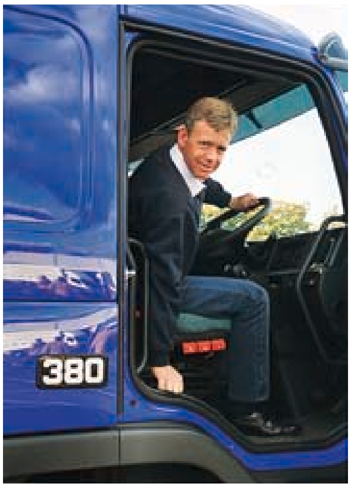
- The make/model etc.
- The specification, such as gross vehicle weight, vehicle size, engine power and torque, and gearbox and final drive ratios.
- The age of the vehicle. The 'Age Fuel' curve, ie the relationship between mpg and age of vehicle may vary between different makes and models. The running-in period of new vehicles also varies. Some vehicles need more running in than others before they perform at their best.
- The condition of the vehicle, engine transmission, axles and tyres etc.
- Operational details such as the dimensional match between tractor and trailer.
- The equipment and products used eg lubricants, aerodynamics.

The vehicle is one of the most influential factors in fuel performance. This includes how well the tractor and trailer are matched.

The sections on maintenance and specification of vehicles have more information on these points.

6.3 THE DRIVER

Apart from the vehicle itself, the way the driver drives the vehicle is considered to be the biggest single influence on fuel consumption. Issues concerning the driver start with recruitment and selection and continue through training, motivation and involvement.



Apart from the vehicle itself, the driver is considered to have the greatest influence on fuel performance.

6.4 THE LOAD

The load being carried will naturally affect a vehicle's fuel performance. Total weight is the critical factor, and this often changes during the journey as deliveries are made. Also, if the load is on a flat trailer, dropside body or tipper, its dimensions and outline profile will have an effect too. On these types of body, sheeting a load or an empty tipper body can save fuel because it reduces aerodynamic drag.

Some claim to have evidence that varying the load actually on each axle can also impact on fuel consumption, although others would dispute this.

The size, weight and shape of the load will affect the fuel consumption.

In the case of high-volume trailers, there is a trade-off between increased payload capacity and the effect on fuel consumption, which, depending on the circumstances, may make them an attractive proposition.

6.5 WEATHER AND SEASONALITY

The weather is another factor influencing fuel consumption. This needs to be remembered when comparing data gathered during different weather conditions. Wind, rain, sleet etc can all have a great impact on performance.

The season of the year also affects performance, with the best consumption figures in summer and the worst in winter.

Cooler temperatures and the shorter days of winter can result in the greater use of auxiliary equipment and drivers idling the engine to keep their cab warm when parked.

Weather and season can have a big impact on fuel performance.

Where there is a change from 'summer grade' diesel fuel to 'winter grade' it can be expected to contribute to a difference in consumption of the order of 3%. This is due to the difference in specific gravity between winter and summer fuels.

Fig 6.1 shows an example of seasonality in a large fleet and clearly indicates how performance in the winter months can be as much as 10% lower than in the summer months.

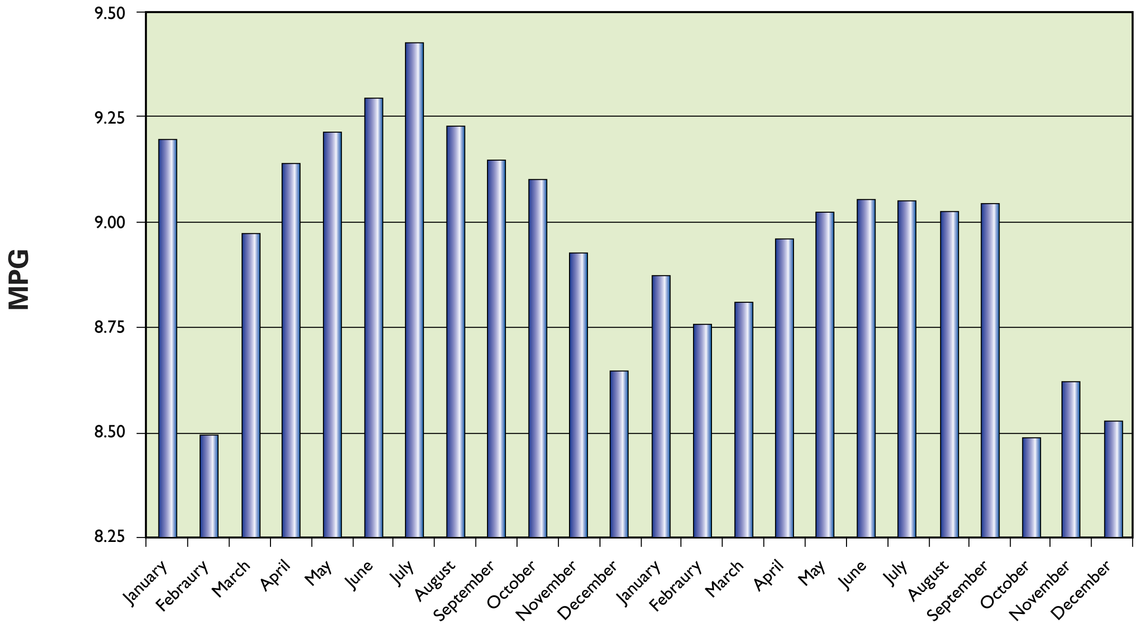


Fig 6.1 Seasonality in a large fleet (Courtesy of the University of Huddersfield)

6.6 ROUTE AND TRAFFIC

The type of road will play its part, with narrow winding roads giving worse fuel consumption than straight dual carriageways. Slow and tortuous routes through hilly terrain will drag down the fuel performance of even the best vehicles.

As a rule of thumb, the more times a driver has to change gear, brake or accelerate, the worse will be the fuel consumption.

A busy, urban environment will also have an impact on fuel consumption because there is a lot of stopping and starting, with the vehicle losing its momentum. Because traffic congestion varies according to the time of day, the same route can throw up different fuel performances. This is normally most noticeable between day and night operations.

Hilly terrain and twisting roads will inevitably exact a toll on the overall average fuel consumption.

6.7 FUEL

The two main properties of fuel are the amount of energy it contains, which is highly dependent on the density of the fuel, and the ease with which it combusts, normally measured by the cetane index and number. Fuel additives (usually blended in by the oil companies) are used to improve combustion. Section 7 examines the subject of fuel in more detail.

6.8 UNDERSTANDING THE EFFECTS OF THE FUEL FACTORS

Drivers should be encouraged to note any specific unusual event or condition on their daily duty sheet. This can then be captured during driver debriefing for later analysis as necessary and appropriate. Examples might include heavy traffic, road works, diversions off route and exceptionally poor weather. Appendix 8A contains a suggested driver daily worksheet. A copy of this also is also provided on the disk supplied with this Guide.

As you become more advanced in the process of fuel management, each of the factors should be investigated and understood in detail for each section of the business.

This may be more easily achieved by those organisations, which have repetitive transport schedules, eg some supermarket deliveries. Measurement of performance on each run over a period of time can give a clearer indication of the impact of the fuel factors such as load, different times of day and different types of trailer etc.

Once the factors are reasonably understood and predictable, targets can be fine tuned and made increasingly relevant.

This is particularly important when testing fuel-saving devices, as there is always a danger that benefits may be wrongly attributed or even hidden by the impact of completely unrelated factors.

The subject of fuel-saving devices is currently being reviewed under the Energy Efficiency Best Practice Programme – advice to fleet operators will be published during 2002. It will cover the various categories of product on the market and how to evaluate any marketing material and test reports, as well as suggesting methods of running in-house fleet trials.

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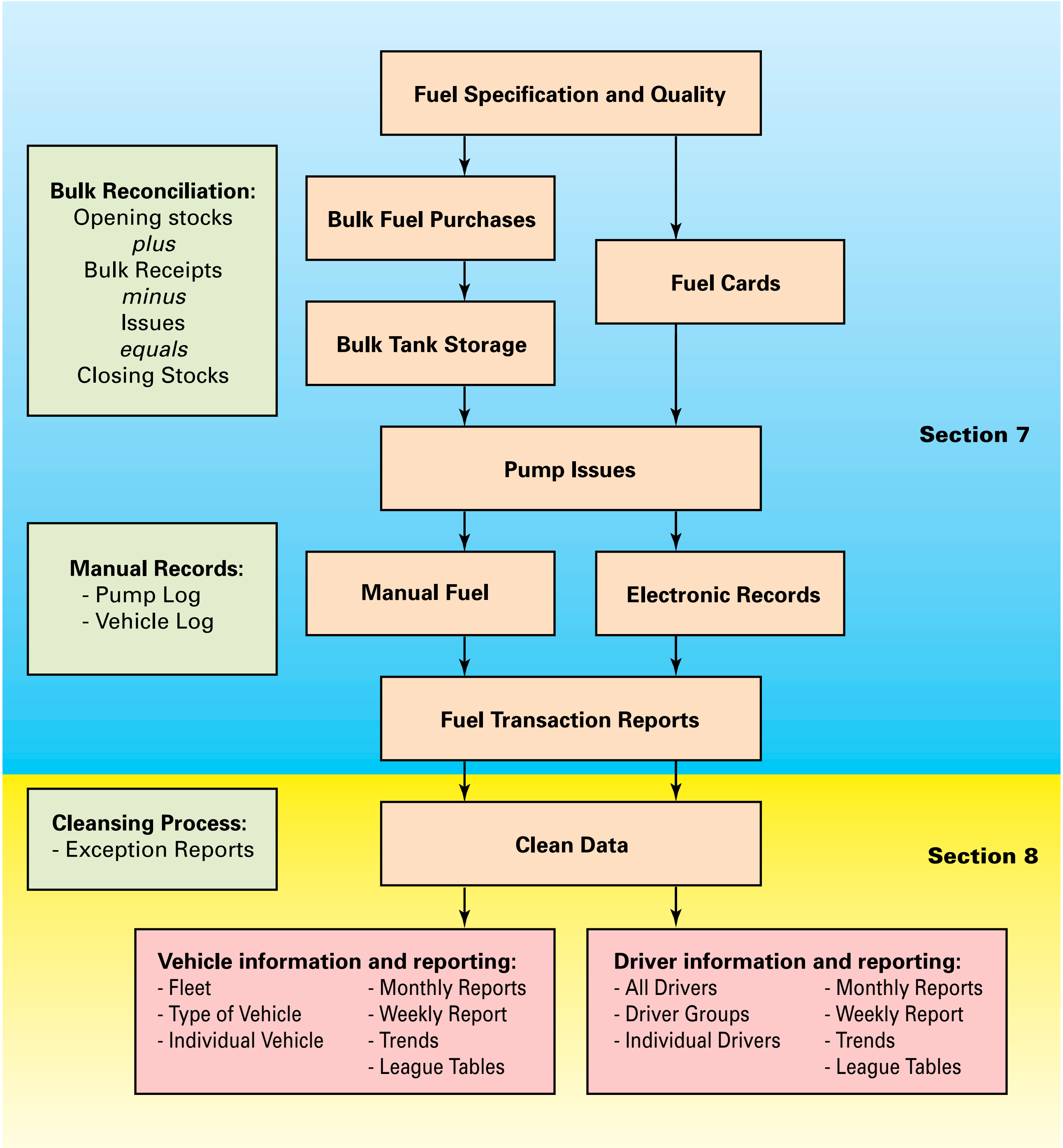
7.1 INTRODUCTION

The next two sections cover fuel and the collection of data. Fig 7.1 shows how the contents are linked between the two sections.

Fig 7.1 Fuel and its associated subjects



Section 7 has been split into seven separate subject areas covering specification and quality, ultra low sulphur diesel, temperature, purchasing, storage, stock control and finally, fuel recording systems.

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7.2 FUEL SPECIFICATION AND QUALITY

The most important characteristic for fuel consumption is the density of the fuel, because in simple terms, the denser the fuel, the more energy it contains. Fuel density is usually measured in kilograms per cubic metre (kg/m^3).

The British Standard, BS EN 590, defines the standard for all types of diesel. Ultra Low Sulphur Diesel (ULSD) was defined in the 1998 Finance Act. Many fuel companies now produce a form of ULSD which has significantly lower levels of sulphur than those required by the standard defined in the 1998 Finance Act. All forms of ULSD sold in the UK conform to BS EN 590.

BS EN 590 (2000):	
General Diesel Density	820 kg to 845 kg per cubic metre at 15°C
Sulphur content	Not more than 350 ppm
Cetane no	Minimum level 51
1998 Finance Act:	
ULSD density	Not more than 835 kg per cubic metre
Sulphur content	Not more than 50 ppm

The fuel's cetane index is a calculated measurement of ignition quality based on the distillation properties of the fuel. Its cetane number is established by experiment and is a further measure of ignition and combustion performance. The higher the cetane index and number, the more efficiently the fuel will ignite and release energy, which should help consumption and performance. Typical cetane numbers for diesel meeting BS EN 590 (200) are 51 to 56.

Diesel also contains additives to assist in combustion and cleaning. Anti-foaming additives are added to reduce diesel foaming, giving faster filling and less risk of spillage.

The fuel supplier will have a specification for the fuel you will be receiving at each of your sites. You should check these as there may be regional differences depending on the supplying depot. Ensure you are receiving the density specified and review whether any regional differences should be taken into account.

7.3 ULTRA LOW SULPHUR DIESEL AND ULTRA ULTRA LOW SULPHUR DIESEL

Ultra low sulphur diesel (ULSD) has been introduced with the objective of reducing emissions. ULSD became virtually the standard diesel throughout the UK in 1999, encouraged by Government duty incentives.

The UK specification for ULSD demands that its sulphur content must be no more than 50 parts per million (ppm) by weight. Standard diesel, as supplied in most other parts of Europe, is allowed to have a sulphur content of up to 350 ppm. Although this is much more than ULSD, it is less than it

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used to be - before 2000 the sulphur limit for conventional diesel in Europe, including the UK, was 500 ppm.

The move from conventional diesel to ULSD also had the effect of reducing the density of the fuel. Whereas conventional diesel used to have a typical density of 840-850 kg/m^3, the density of ULSD is typically close to 830 kg/m^3, (and by UK law can be anywhere between 820-835 kg/m^3), and therefore contains less energy.

Many fuel companies now produce a form of ultra low sulphur diesel with an even lower sulphur content, typically 10-15 parts per million. This is sometimes known as ultra ultra low sulphur diesel.

As a result of these density reductions, ULSD contains marginally less energy for a given volume of fuel than the previous traditional diesel. However, oil companies say that other factors such as cetane number adjustments and other additives can offset this density reduction.

7.4 TEMPERATURE

Diesel fuel expands and contracts as its temperature varies. Consequently, the temperature at which it is measured affects the volume and energy contained in a given volume. Fuel delivered at a high temperature and dispensed at low temperatures will show a loss in volume (although the effect is relatively small - a change in temperature of 25°C will change volume by just under 2%).

A depot very close to a refinery may get deliveries at above average temperatures. Very large customers may be able to negotiate a correction factor back to 15°C, which is the standard temperature for fuel specifications.

7.5 FUEL PURCHASING

Many organisations will have purchasing departments that use sophisticated techniques for buying their fuel. This section contains some tips for those without access to such experts.

Purchasing options:

- Buying on the spot market - ringing several suppliers for a quote each time you need a fuel delivery - takes time and effort but can give you advantageous fuel prices.

You can now use the internet to help get the best value for money from purchasing fuel.

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- You can contract buy, either at ruling prices or based on an index such as 'Platts', or at prices fixed for several months.
- You can use fuel cards or outside bunkering facilities (Appendix 7.B).
- You can set up an account, and negotiate prices at a local service station.
- You can join a buying co-operative.
- You can use specialist internet sites.

If you are buying fuel for your own on-site storage tank, here are a few tips and issues to consider:

- Buying full tanker loads (if your storage tank has the capacity) is usually cheaper than buying part loads.
- Reducing your credit risk rating in the suppliers' eyes may improve your purchasing power and ability to negotiate sharper prices.
- The ability to accept out-of-hours deliveries may save some money.
- Paying fuel invoices promptly may help shave the price a little.
- Find out which is the nearest terminal to your site and establish which oil companies operate from it. Because of their proximity to you they should be able to offer the keenest prices.
- If buying from several suppliers, it is a good idea to demonstrate a degree of loyalty to at least one of them. If for some reason, supply becomes tight, it is comforting to know that you are viewed as an important customer. Continuity of supply is ultimately more important than shaving the price.
- Audit fuel purchasing procedures from time to time to ensure that the buying process is operating to the best advantage of the organisation.

7.6 FUEL STORAGE

7.6.1 Holding your own bulk stocks

Deciding whether to hold your own bulk stocks, or to rely on fuel cards, bunkering facilities or an arrangement with a local service station is often a complicated decision.

Issues to be considered include the following:

- convenience of home base filling;
- supply availability;

Deciding whether to hold your own bulk fuel stocks is often a complicated decision.

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- reliability and quality of supply;
- cost saving in bulk purchase of product;
- cost of equipment;
- managing the storage, including environmental and security issues;
- control over transactions;
- bunkering and/or credit card suppliers can provide many of the management functions required (Appendix 7.B).

If you have bulk tanks on site, you need to consider the points in the following sections.

7.6.2 Checking for water

Monitor diesel storage tanks for water contamination. One method is to use water identification paste on the dipstick. (Water identification paste can generally be obtained from fuel equipment maintenance companies.) A visual check of a sample of fuel can also usually show this contamination.

A large proportion of tanks have high levels of contamination – one survey showed that 50% of tanks tested were contaminated with water and 63% with bacteria. The consequences can be serious. Water causes poor combustion, clogged filters, corrosion and fuel line freeze-ups. Bacteria cause slime formation, fuel oxidation and corrosion, and clog filters and injectors. Bacteria can multiply very quickly in a water/diesel mixture. In short, both types of contamination will have a detrimental effect on your vehicles' performance.

7.6.3 Tank maintenance

The frequency of tank maintenance depends on the amount of usage. Operators using high volumes of fuel might aim to have the tank filters checked and cleaned or replaced every six months, and the tanks de-sludged every 12 months. Smaller users may opt for less frequent maintenance.

Maintenance of the bund that surrounds the tank is also vital. It must hold at least 110 per cent of the tank's capacity, and must also be able to retain complete integrity.

The Environment Agency can provide information on suitable designs and ways to minimise the release of fumes into the atmosphere.

7.6.4 Fuel measuring system maintenance

Whether you have just one pump with no other equipment, or a sophisticated fuel monitoring system downloading information to a personal computer (PC), an important factor in ensuring the accuracy of your data will be the accuracy of the measuring system. (See section 8.2 for details of

pump accuracy.)

Consequently, the pump should be checked, maintained and calibrated regularly. The frequency obviously depends on usage, but as a rule of thumb, it should be at least annually and preferably six-monthly for heavy users.

If you are regularly reconciling bulk stocks (see Section 7.7 on stock control), you should be able to spot potential problems with pump calibration.

7.6.5 Checking fuel samples

If you consistently use the same supplier, you may wish to have a fuel sample from the fuel supplier checked once a year by a laboratory and compare this with the supplier's fuel specification, a copy of which should always be held on site.

The laboratory test will verify such things as density, flash-point and cetane number. Contaminants can also be identified. This testing should cost no more than a few hundred pounds.

For real confidence that fuel is being measured and dispensed accurately, pumps should be calibrated once or twice a year.

7.7 STOCK CONTROL

7.7.1 Stock records

If you have your own in-house storage it is vital that you maintain accurate stock records, eg along the lines of Fig 7.2 Both gains and losses of fuel stocks are possible and you need to take action in either case. A blank copy of this stock record sheet is provided on the disk supplied with this Guide.

Leakage, theft, short delivery and inaccurate pump calibrations are some of the obvious dangers that need to be detected as soon as possible. It is a good discipline to carry out a weekly stock reconciliation, checking actual stock against stock records.

The contents of a bulk fuel tank at any one time should be equal to:

Opening stock (ie stock when last checked)

plus

quantity of recorded fuel delivered since last checked

less

quantity of recorded fuel drawn since last check.

In practice, the theoretical 'closing stock' will rarely match a physical stock measurement precisely. This may be due to a number of reasons including:

- inaccurate measurement of stock (dipsticks and pressure gauges are not very accurate);
- incorrectly recorded fuel delivery;
- incorrectly recorded fuel drawn, due to the pump being wrongly calibrated, manual errors or fuel being misappropriated;
- leakage from the tank or pipework;
- water contamination from condensation or leakage into the tank;

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- contraction/expansion of fuel depending on temperature of fuel.

Fig 7.2 Example of fuel stock record sheet

Depot Number		Date	
Tank Number		Week	

Week Number	(1) Tank Dip (litres)	(2) Deliveries (litres)	(3) Cumulative Meter Reading	(4) Issues (litres)	(5) Balance (litres)	(6) Gain/Loss (litres)	(7) Cumulative Gain/Loss (litres)
1	1,965	12,000	94,163				
2	11,130		96,977	2,814	11,151	-21	-21
3	9,000		99,099	2,122	9,008	-8	-29
4	6,295		101,786	2,687	6,313	-18	-47
5	4,230	12,000	103,749	1,963	4,332	-102	-149
6	13,830		106,256	2,507	13,723	107	-42
7	10,895		109,172	2,916	10,914	-19	-61
8	9,375		110,684	1,512	9,383	-8	-69
9	7,380		112,643	1,959	7,416	-36	-105
10	4,630			2,764	4,616	14	-91

TOTAL ISSUES	21,244
Cumulative Gain/Loss	-91
% Gain/Loss	-0.4%

Column Explanation

(1) Tank dip to be taken at end of week - Saturday, 18:30

(2) Tanker deliveries during week

(3) Cumulative fuel pump meter reading to be taken at end of week - Saturday, 18:30

(4) Calculated as [column (3) for THIS week - column (3) for LAST week]

(5) Calculated as [column (1) for LAST WEEK + column (2) for LAST WEEK - column (4) for THIS WEEK]

(6) Calculated as [column (1) for THIS week - column (5) for THIS week]

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(7) Calculated as [column (6) for THIS week + column (7) for LAST week]

7.7.2 Fuel tanker deliveries

Wherever possible, written procedures should exist for functions such as fuel tanker deliveries. A typical example is shown in the appendix to this section. The following are some issues which should be included.

- Deliveries of fuel should always be overseen by a responsible person, who must first ensure that the correct tank is being used (ie not mixing derv with red diesel) and that it has capacity to accept the delivery.
- The responsible person should carry out a dip of their own fuel tank before and after delivery, allowing 10 seconds in position and ensuring the stick does not bounce.
- The responsible person should know the site's emergency spillage plan, including the location of spillage containment equipment such as surface water drain covers.
- Remember that agitation of the fuel (eg following a bulk delivery of fuel) may result in a tank dip showing a higher than true reading.
- Where possible, stop vehicles drawing fuel during the delivery and while checking stock levels as this will affect the accuracy of any measurement. This is particularly important when remote computer systems are in operation if misleading apparent stock losses or gains are to be avoided.

7.7.3 Reviewing stock control records

You should maintain cumulative records of stock losses/gains and their percentage of total fuel used (see Fig 7.2).

It is difficult to be precise about the level of loss/gain that should trigger an investigation. As a rule of thumb, if the trend of cumulative losses/gains exceeds 0.5 % of the total volume dispensed over a reasonable period (say four reconciliations), you should satisfy yourself that these are simply caused by cumulative inaccuracies of the measurement system rather than by anything more worrying.

If a totally accurate reconciliation is achieved, it is worth investigating fully to ensure that 'imaginative management' has not been at work and that the figures are really that accurate!

7.7.4 Fuelling away from base

A regular cause of distorted fuel consumption figures is the failure to capture data about fuel purchased off-site accurately. Receipts for off-site refuelling must therefore specify total number of litres, the monetary value and vehicle identifier, include the odometer reading and should record the driver(s) responsible.

It is recommended that you set up a rigorous system to ensure that data are captured accurately, eg

all invoices and statements balanced back to the entries put into the vehicle fuel records.

If you notice any poor performance after vehicles have refuelled off-site, you may wish to test the fuel from that source to check for any abnormalities - there have been instances of fuel being diluted with paraffin. Paraffin/kerosene lacks lubrication qualities so the increased friction may accelerate internal engine wear in the injection pump and injectors.

There have also been cases reported of so-called diesel laundering, which is the removal of the red dye in the lower taxed red diesel.

7.8 FUEL RECORDING SYSTEMS

Many organisations will have some form of fuel recording system connected to their in-house bulk storage tanks. These systems have varying degrees of sophistication and the choice between them depends on the organisation's desire for accurate data, the size of the fleet and the fuel usage, and the true cost of the alternatives.

Capital cost is, of course, also a consideration. When first choosing a system, it pays to think ahead, perhaps opting for a system that can be upgraded rather than replaced as the fleet develops.

In the simplest of systems, all fuel used is recorded manually by noting readings on the pump. The fuel records are then collated and used to produce reports.

Figs 7.3 and 7.4 show some typical layouts for pump issue and vehicle drawing reports for a manual system.

The next level of system involves attaching a stand-alone fuel island controller (FIC) to the pump. Normally this records date and time of transaction, quantity of fuel delivered, vehicle and driver, although not all can capture driver identity.

Its main purpose is to restrict the use of the pump to authorised users only, but the information it collects is the first step towards data acquisition and hence real fuel management. Information can be either printed on a small 'till roll' type printer attached to the FIC, or downloaded onto a microchip-based module, which can be used to transfer the information to an office-based computer.

Fig 7.3 Example of manual pump fuel issue sheet

Date: ______________________ Depot: ______________________

Date	Time meter	Pump meter start	Pump (litres) end	Fuel	Veh No	Reg No	Tacho (km)	Driver name	No	Signature
16-Feb	6.30	497698.5	497854.8	156.3	23	N417KCX	112,822	M.R.	1	
16-Feb	7.15	497854.8	497916.2	61.4	22	N416PYT	654,761	R.R.	23	
16-Feb	7.20	497916.2	498097.1	180.9	17	G702PTP	157,788	P.B.	11	
16-Feb	7.25	498097.1	498321.8	224.7	5	J311FTP	75,664	P.W.	2	
16-Feb	7.45	498321.8	498344.1	22.3	15	L438HPW	372,688	B.T.	12	
16-Feb	8.00	498344.1	498441.4	97.3	1	F904AJM	762,990	T.O.	37	
16-Feb	13.45	498441.4	498596.7	155.3	20	L661FPG	31,886	T.D.	5	
16-Feb	15.10	498596.7	498669.9	73.2	6	K57PJN	164,367	J.S.	14	
16-Feb	15.20	498669.9	498703.5	33.6	3	K812AXT	722,344	F.S.	19	
16-Feb	18.15	498703.5	498762.2	58.7	26	L802XPA	611,876	O.S.	15	
16-Feb	18.35	498762.2	499008.0	245.8	14	D433MDP	21,887	N.A.	3	
16-Feb	18.40	499008.0	499123.7	115.7	26	L802XPA	71,005	S.M.	20	
16-Feb	18.45	499123.7	499192.6	68.9	30	S107XEJ	550,881	A.G.N.	99	
16-Feb	18.50	499192.6	499246.2	53.6	4	P499YRV	700,122	D.M.	9	
16-Feb	19.05	499246.2	499345.0	98.8	25	L542XSP	390,885	T.H.	10	
16-Feb	19.45	499345.0	499522.3	177.3	9	L307UPJ	223,905	J.B.	22	
16-Feb	19.55	499522.3	499725.4	203.1	16	H864FJX	25,665	P.D.	13	
16-Feb	20.10	499725.4	499760.4	35.0	17	G702PTP	157,899	J.W.	4	
16-Feb	20.50	499760.4	499912.3	151.9	22	N416PYT	655,223	Q.F.	8	
16-Feb	21.00	499912.3	499949.8	37.5	15	L438HPW	372,808	D.A.	7	
16-Feb	23.30	499949.8	500151.5	201.7	2	F904AJM	166,522	A.R.	6	
16-Feb	23.45	500151.5	500263.6	112.1	20	L661FPG	69,088	R.M.	27	
16-Feb	23.50	500263.6	500432.4	168.8	23	N417KCX	19,881	C.R.	16	

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The highlighted figures refer to other schedules in this download. In order to give a flow through picture of the transaction data, see Fig 7.4.

Fig 7.4 Example of manual vehicle weekly fuel sheet

CHECK FOR FUEL CONSUMPTION

Vehicle Reg. No. L438HPW Month Feb Year 2002

Fleet No. 15

Speedo reading at last fill up **372,642**

Please record ALL fuel purchases for this vehicle from whatever source received.
This sheet must remain with the same vehicle for the week. Please print details clearly.

Date	Speedo reading	Fuel (litres)	Driver Name	Driver No.	Signature	Fuel from	Pump reading (end)
16-Feb	372,688	22.3	Thompson	12		Depot	498344.1
16-Feb	372,808	37.5	Arthur	7		Depot	499949.8
17-Feb	373,085	96.0	Arthur	7		Depot	500865.3
18-Feb	373,453	111.2	Arthur	7		Depot	503544.9
19-Feb	373,710	20.0	Arthur	7		Stavid s/s	Off site
19-Feb	373,767	86.0	Arthur	7		Depot	505118.6
20-Feb	374,082	103.0	Arthur	7		Depot	507766.1

Please Note:

1. You must fill up completely at the end of each shift.
2. Hand this form to the supervisor at the end of each week with all agency tickets.
3. Collect a new sheet and enter the last mileage immediately.

4. Note any unusual factors affecting your fuel consumption, such as traffic jams, very poor weather, etc.

Operators with more than about 20 vehicles fuelling at a single site will undoubtedly need a fuel management system that allows them to do more than merely safeguard stocks. Here a two-part system is typical, with an FIC controlling more than one pump and communicating all data to a central computer running PC-based software.

The two-part system also allows greater flexibility in identifying drivers and vehicles, with driver keys, electronic keys, swipe cards and PIN numbers supplemented by more sophisticated devices. In some systems, vehicle identification and mileage data are transmitted from the vehicle via a short-wave radio transmitter to a receiver mounted on the fuel island.

Systems have now been developed to ensure correct driver, vehicle and odometer readings are captured using driver identification by fingerprint, nozzles capable of identifying the vehicle from specially designed vehicle filling necks which can also transmit the current odometer reading on the vehicle.

There are several ways of identifying drivers and vehicles.

At the top end of the scale there are multi-site fuel management systems to provide detailed information and reports from fuelling sites situated throughout the country. This information is often merged with data from off-site fuelling via fuel cards, to provide the total fuelling 'picture' for a fleet. A central head office can poll (via a telephone modem connection) any number of sites to gather and collate fuelling data.

There are numerous reporting options covering all aspects of fuel management. Graphing options and exception reports can highlight key facts from a wealth of data. Used effectively, they can make it much easier to spot the thirstiest vehicles, the most economical drivers or the toughest routes. Other patterns such as seasonality also begin to emerge.

Invest in the best data collection system you can justify, taking into account time spent and potential fuel savings.

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APPENDIX 7.A FUEL STOCKS/USE RECONCILIATION PROCEDURE

1 Ordering Fuel

It will be the responsibility of the manager or deputy to ensure that fuel stocks are regularly checked and to maintain an adequate supply at all times.

Supplies of fuel must be obtained from a recognised, approved supplier, which may mean a 'national' contract with one or more suppliers.

2 General Points

If possible, vehicle refuelling should not be permitted during bulk tank reconciliation or weekly bulk tank reconciliations in order to make reconciliations more accurate.

The delivery area must be free from hazards. Fuel bunds must be checked weekly, and any accumulated water or leaking fuels disposed of safely. Any obvious fuel leaks must be reported immediately and repairs actioned.

Any spills must be removed or covered by an absorbent material as soon as possible. Supplies of absorbent material must be available at all times.

3 Bulk Delivery of Fuel

Before the delivery commences, check the dip/gauge on the receiving bulk fuel tank, and note the quantity contained.

Check dips/meter readings on the vehicle before and after delivery.

Check the dip/gauge on the receiving tank after delivery and agree the quantity delivered to both vehicle dips/meter and tank dips/gauge.

Check quantity on the delivery document, sign it and retain a copy.

Make the delivery point secure. Ensure the tanker leaves the site safely.

4 Equipment Calibration

Fuel tank monitoring equipment (ie normally dipsticks or gauges) should be calibrated on original installation or purchase.

Fuel pumps should be maintained and calibrated regularly (frequency of calibration will depend on level of usage. See Section 7.6.4).

APPENDIX 7.B FUEL CARDS

1 INTRODUCTION

The fuel card providers have recognised that managing fuel is an important and time-consuming job. So they now offer a range of services designed to combine the convenience of cashless refuelling anywhere in the country with improved management reporting and control.

The same principles will apply to European-wide cards, although the time taken to collect data from different countries tends to vary.

2 OPTIONS

Fuel card suppliers fit into three broad categories:

Retail

This is a card accepted at sites nationwide, with fuel being purchased at pump price. This provides the driver with a high level of choice in which service station to use, but means that fuel is purchased at the retail forecourt rate.

Oil companies

Almost all oil companies now operate fuel cards, which are accepted at that company's service station network. This restricts choice and can mean drivers searching for the right garage, but at least it is easy for a driver to identify the garages that accept the card.

Bunkering

Bunkering companies are free of ties from oil companies. Large customers, such as those buying more than about 20,000 litres per month, buy at commercial market rates and deposit their fuel into the system. Smaller users buy from approved dealers and pay only for the fuel used, without making the larger bulk purchase.

Fuel purchased this way is made available through a multi-branded network of filling stations and automated refuelling sites.

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3 CARD FEATURES

The following features need to be considered when comparing cards and the companies issuing them:

- the location of their network, a good selection of sites on trunk roads, main distribution hubs and destinations;
- anti-fraud measures, such as driver and vehicle recognition, pin numbers etc.;
- reliability of data, vehicle, odometer and driver information;
- price and quality of fuel;
- product restrictions, limiting the card's use to fuel and lubricants, tolls etc (this facility is also increasingly becoming available on the continent);
- the efficiency of dealing with the problem of stolen and lost cards;
- type and quality of reports; is there an early warning system of irregular fuel drawings?
- ability to export transaction data into a fuel management system;
- ability to rectify errors such as incorrect mileage readings;
- possibility of using the card for home base fuelling;
- speed of reporting.

4 CARD COSTS

The convenience and management service provided by fuel cards do not come free of charge. Costs normally include a card cost per annum, report charges and, in the case of bunkering facilities, a handling fee per litre bunkering. If an operator's own on-site fuel storage is connected to the

bunkering system, there could also be software and modem charges.

APPENDIX 7.C ALTERNATIVE FUELS

1 INTRODUCTION

Three main factors have led to a surge of interest in alternative fuels:

- the high prices of conventional fuels;
- a Government initiative (Powershift);
- the 'Green' effect of these fuels as they affect emissions.

This hydrogen-powered MAN articulated bus operates at Munich Airport. The hydrogen tanks are on the roof.

However, compared to diesel, they require a greater volume of fuel for the same energy output, which causes a number of problems, both physical and financial. This may include loss of payload.

The main alternative fuels are:

Compressed Natural Gas (CNG) and Liquid Natural Gas (LNG)

Liquid Petroleum Gas (LPG)

Electricity

The following are also classified as 'alternative fuels' and may become more significant in the future:

Biogas

DiMethyl Ether (DME)

Rape Methylester (RME)

Ethyl Alcohol

Methyl Alcohol

2 NATURAL GAS - Compressed Natural Gas and Liquid Natural Gas

Natural gas consists of 85-95% methane, which is the simplest hydrocarbon. It is colourless, odourless, tasteless & inflammable. There has been a misconception regarding this fossil fuel about the risk of explosion. Although explosion is possible (as it is of course with conventional fuels), the following compensate for this:

- it disperses in the event of a leakage as it is lighter than air;
- the diffusion coefficient is high in comparison with conventional fuels and therefore it dilutes rapidly in ambient air;
- the auto-ignition temperature is higher than conventional fuels and flammability limits are narrow by comparison with them;
- fitting of pressure relief valves to tanks ensures against increases in tank pressure which causes the main risk of explosion.

Compressed natural gas (CNG) and liquefied natural gas (LNG) have become more attractive in recent years because of advantageous duty rates, capital grants and growing commercial development.

When stored in a compressed form, it is known as Compressed Natural Gas (**CNG**). Alternatively, when held at a temperature of approximately -162°C it liquefies and is then known as Liquid Natural Gas (**LNG**).

The combustion of natural gas reduces carbon dioxide (although not appreciably), nitric oxide and particle emissions but increases methane output (that can be oxidised by a catalyst). Engine noise also reduces due to improved combustion characteristics. The technology is well developed. 1 litre of diesel corresponds to 3.35 litres of CNG at a pressure of 200 bars.

Some technical properties are specific to natural gas. A more complicated tank system is required. Larger heavier tanks are needed for the same range and are thus best suited for short trips until and unless sufficient refuelling points are available. The impact of any loss of pay load should be taken into account.

LNG has a higher energy content than CNG so needs less storage space, but is held at lower temperature and pressure than CNG.

There are relatively good supplies of natural gas around the world, certainly more than oil. It can be transported, as it is in the UK, by pipeline. Manufacturers see CNG as a complement to diesel in local regional traffic. However, more development is still needed to obtain the best from this fuel.

Operations within a relatively small radius of base are not penalised by the limited amount of fuel storage on a CNG-powered vehicle like this 3.5 tonne gvw Iveco Ford.

As at 2002, there are about 33 sites available for CNG/LNG refuelling in the UK. Larger fleet operations using CNG/LNG usually install a fuel bunker at their depot.

3 LIQUID PETROLEUM GAS - LPG

LPG consists of various hydrocarbons. In the UK, LPG is predominately propane. It is a by-product of oil refining and also found associated with natural gas fields.

Compared to diesel, LPG produces significantly lower emissions of nitrous oxides and particulates. Compared to petrol, LPG emissions are lower in all regulated pollutants with approximately a 10% reduction in CO_2.

1 litre of diesel corresponds to 1.4 – 1.5 litres of LPG. LPG is currently taking off in the UK at the smaller end of the vehicle market (cars and vans). It is currently available at over 1100 open access sites.

4 ELECTRICITY

Electrically driven vehicles have low noise levels and no emissions at the point of use – emissions will occur of course at the site generating electricity.

Current battery capacity means the range of these vehicles is about 50 miles. These vehicles therefore are best used for short, urban deliveries. For example, electric milk floats have been used for many years.

The batteries can be charged at any 13A socket. Fast charging is possible using the latest technology, but there are very few facilities. Smaller electric vehicles in a specific project in Coventry do around 100 miles per day with top-up charging at stops and lunch breaks.

5 COSTS

There are two main aspects to consider when converting to alternative fuels:

- Cost of conversion. At present there are Government funding schemes available which may contribute up to 75% of this cost depending on the emissions saved. Contact Transport Action to find out how to apply for a grant on 0845 602 1425 or at www.transportaction.org.uk
- Cost of running. The Transport Action website includes a calculator that can be used to estimate the cost of various options.

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6 SOME KEY ISSUES

When considering the use of alternative fuels, the following are some of the key issues to take into account:

- the benefits of the 'green' approach to your business;
- the pros and cons of each fuel;
- supply availability;
- distances and tank range with refill points;
- like-for-like comparisons ie mpg or km/100 litres;
- conversion costs or premium on new vehicles;
- running costs;
- running a controlled trial for evaluation purposes;
- present funding available;
- resale value of vehicle;
- your vehicle can be used in Air Quality Management Areas (declared by over 90 local authorities already).

Combining the best of both worlds, this hybrid Mercedes-Benz Vario 814 keeps its own diesel engine for long distance work, but has a small electric motor powered by the banks of batteries, for urban use.

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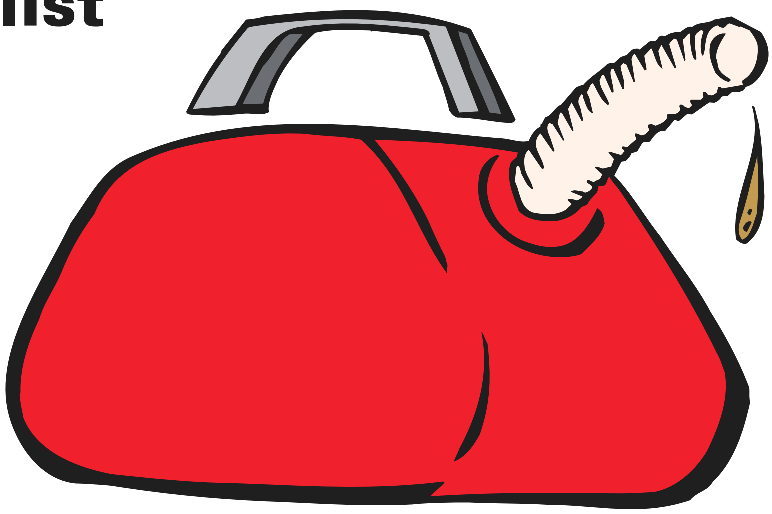
Checklist



Section	*Things to do*	*In place*	*Done*	*Not appropriate*
7.2	Obtain and compare specifications for fuel to be supplied to each site. Compare different suppliers	☐	☐	☐
7.3	Monitor impact of changing fuel specification eg to ULSD	☐	☐	☐
7.5	Review current purchasing arrangements	☐	☐	☐
7.6.1	Review whether to have in-house fuel stocks	☐	☐	☐
7.6.2	Check regularly for water in fuel storage tanks	☐	☐	☐
7.6.3 7.6.4	Set up maintenance contract for tank filter replacement, tank de-sludging, fuel pump calibration and monitoring system	☐	☐	☐
7.6.5	Consider testing fuel annually for density, flash point, cetane number, etc.	☐	☐	☐
7.7.1	Monitor physical stocks and cumulative losses	☐	☐	☐
7.7.2	Review any written procedures for best practice. If they don't exist, consider writing up important procedures and publishing them	☐	☐	☐
7.7.4	Monitor and check performance from off-site refuelling	☐	☐	☐

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8.1 INTRODUCTION

Without good data there is not the same ability to generate long term improvement in fuel performance, monitor and target successfully, or measure the improvements from any initiative.

So, the following four steps are essential in any fuel management programme:

- setting up a system of collecting data;
- making sure data are collected accurately;
- cleaning-up data;
- analysing and interpreting the data.

The systems for collecting data are covered in more detail in Section 7. In principle, the main options are:

- collect data manually and key into a spreadsheet or database;
- collect data from the fuel pump and upload electronically into a computer spreadsheet or database;
- use fuel cards, and either use their reporting systems, or upload them electronically into a computer spreadsheet or database.

In reality, systems are unlikely to be exclusively one or another, and are more likely to be a mixture of two or more of the above.

A different approach is to monitor the amount of fuel that actually goes through each vehicle's engine by using an on-board device. Many modern trucks with electronically controlled engines can be specified with an optional on-board data system that can capture this information.

It is also possible to fit a separate fuel flowmeter and link this to a proprietary on-board computer to record the fuel consumption.

Allied to the appropriate download method and computer software, either should give good quality data about individual vehicle and driver performance, and both have the advantage of measuring fuel actually going into the engine, rather than being dispensed from the storage tank.

However, this approach does have some limitations. It does not control bulk fuel stock, ie reconciling deliveries and the amount of fuel dispensed.

It is also expensive because the fuel measurement system is replicated on each vehicle rather than a single system monitoring the whole fleet. So it may be necessary to treat on-board devices as an addition to the basic pump system rather than as a replacement for it. On-board computers are covered in more detail in Appendix 2.

NOTE OF CAUTION: Be aware that fuel flowmeters are often fitted with filters. If fitted, make sure that these are properly serviced!

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It is recommended that even if fuel figures are collected manually, they should be keyed into a spreadsheet or database to make analysis, interpretation and presentation much easier. All the calculations can be done manually but unless the fleet is very small, it is the sort of time-consuming and laborious task that is best suited to a computer.

Some example spreadsheets to help you manage your fuel data can be found on the disk provided with this Guide.

It is important to ensure that you collect and retain raw data (ie fuel used and distance travelled) to avoid creating errors by averaging mpg figures. In other words, when averaging fuel consumption over any period the totals of distance and volumes should be used, not averages of the mpg.

CASE STUDY

The perils of averaging mpgs

By averaging mpgs rather than using raw data, Company X thought that its performance was better than it actually was. The following example of averaging the performance of six vehicles over a week demonstrates the problem:

Vehicle 1 travelled 742 miles using 73.2 gallons of fuel, achieving 10.14 mpg

Vehicle 2 travelled 626 miles using 57.6 gallons of fuel, achieving 10.87 mpg

Vehicle 3 travelled 1,746 miles using 222.4 gallons of fuel, achieving 7.85 mpg

Vehicle 4 travelled 1,463 miles using 173.5 gallons of fuel, achieving 8.43 mpg

Vehicle 5 travelled 1,562 miles using 210.0 gallons of fuel, achieving 7.44 mpg

Vehicle 6 travelled 2,050 miles using 265.1 gallons of fuel, achieving 7.73 mpg

Total over the six vehicles over the week = 8,189 miles and 1,001.8 gallons

Simply averaging the individual vehicle weekly mpg figures gives a result of 8.74 mpg (52.46/6).

However, the true fleet mpg is 8.17 mpg (8,189/1,001.8) – a difference of 0.57 mpg or 7%

The remainder of this section deals with collecting and using data collected from fuel dispensing pump systems, which are the most common source of data. However the data are collected, the techniques for cleaning-up and analysis are the same.

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8.2 COLLECTING DATA ACCURATELY

It is very nearly impossible to ensure that data are captured absolutely accurately because there are so many opportunities for errors to creep in. So it is important to identify and then eliminate as many of the potential errors as possible at source. It is easier to do this than attempt to correct the data after the event.

Gathering reliable refuelling data means setting up thorough systems and procedures to reduce the impact of the many errors that can creep in.

8.2.1 Equipment or system errors

These are errors that are inherent in the system. They are normally unavoidable and the data can either be adjusted to correct it or the impact minimised by ensuring that all vehicles are incorrect by the same amount.

Distance readings generated by the vehicle's tachograph come into the system error category. Tachographs have to be accurate to within two per cent on distance reading when installed, but up to four per cent inaccuracy (in either direction) is permitted in use. This extra latitude is to allow for another unavoidable inaccuracy that develops as the tyres on the drive axle wear.

A typical 295/80R22.5 tyre with 4 mm of tread left has a circumference that is three per cent smaller than when it started with 19 mm of tread. So as the tyres wear, the tachograph progressively over-estimates distance travelled, giving an optimistic view of fuel consumption.

It is easy to spot the inaccuracy of these distance measurements by running a variety of vehicles on a regular, simple, out-and-back route of several hundred kilometres.

Another routine source of system inaccuracy is the fuel-dispensing pump. In-house pumps on an operator's site do not have to conform to the standards that apply to garage forecourt pumps. The real problem arises when there is more than one pump and they have different levels of accuracy, thus producing variable and misleading consumption figures. Pump accuracy can slip with use, so regular recalibration is recommended - at least every year, and ideally every six months.

Pump manufacturers will generally offer two grades of pump – the cheaper one, not surprisingly, is less accurate than the more expensive one. Check the accuracy level quoted for your pump(s).

It is not so easy to deal with inaccuracy that occurs due to variation in fuel temperature, but at least one can recognise it. Because diesel expands as its temperature rises, a given volume will contain a different amount of energy depending on the temperature.

This should not be over-stated, the difference in volume between diesel at 30°C and at 5°C is just under two per cent. If correcting for this level of error is required, Appendix 4 of the *Fuel Consumption Evaluation Guide* (FCE), provides details of the calculations required. This Energy Efficiency Best Practice Programme Guide is produced in conjunction with the Institute of Road Transport Engineers (IRTE), one of the two professional sections within the Society of Engineers (SOE) and is available free of charge from the Helpline.

Tachographs must be accurate to 2% on distance reading when installed, but up to 4% inaccuracy is permitted in use to allow for inaccuracies such as the effect of drive axle tyre wear.

From time to time, equipment will break down, so it is a good idea to have some contingency plans to handle the data while repairs are in hand. Either attempt to maintain manual records and then key these into the system when it is up and running; or, close-off the records before the breakdown and restart them again when the system is back, accepting that you have lost data while the system was down.

8.2.2 Operator errors

Apart from deliberate falsifications, operator errors occur when people make mistakes, normally through poor systems, carelessness, lack of knowledge, lack of good disciplines, or time pressures. Common examples include entering incorrect odometer readings into fuel monitoring systems, failing to capture off-site filling information accurately and poor procedures such as failing to refuel at the end of the shift or only partially filling the vehicle fuel tank.

These errors can be minimised by good housekeeping and strong procedures, helped by all involved knowing the importance of doing it right. Automatic in-built checks help; for example, some fuel monitoring systems can automatically generate a report listing vehicles that have not been refuelled in a set period.

With manual systems that rely on written entries to record fuel dispensed, operator error is even more likely. You should therefore consider keeping two separate records – one at the pump recording the fuel issued (see Fig 7.3), the other in each vehicle to record fuel drawn (see Fig 7.4). Reconciliation of the two systems should balance.

Similarly, reconcile the batch total of fuel issued with the difference in the pump's meter readings (as in Fig 7.2). The two should tally if all is in order.

Another safeguard is for the driver to record the diesel drawn and distance travelled on his daily log sheet. Encourage the driver to calculate the vehicle's fuel performance on a shift by shift basis. Appendix 8A contains an example of how this might look. A copy of this report is also provided on the disk supplied with this Guide.

Capturing off-site refuelling is another area wide open to operator error, either by failing to record it or simply by mishandling it (such as a keying error or attributing it to the wrong vehicle or date). The best approach is to set up a simple but robust procedure for handling fuel receipts or fuel card slips. Processing the information while it is still fresh is a good principle and allows mistakes or missing receipts to be spotted quickly, giving the best chance of recovery.

You may be able to import the data electronically if your fuel card/service station company and monitoring system have the capability. Be aware, though, that you will need to instil into the drivers the discipline of ensuring that the information on the fuel voucher (vehicle registration, odometer reading etc) are accurate. You can still expect some errors, however, eg where the filling station operator mis-keys odometer readings etc.

If you have to re-key off-site refuellings, it is helpful for any off-site refuelling record sheet to have an identical layout to the input screen on the fuel monitoring system. Both should be designed to minimise the risk of keying errors. Frequent checks on fuel consumption figures will quickly pick up a missing or incorrect off-site fuelling entry, giving the best chance of sorting it out.

8.2.3 Checklist to minimise errors

Here is a quick checklist that may highlight other sources of fuel data errors:

- Is there an audit trail?
- Is the method of data entry consistent for all people involved?
- Do those people have the authority to take action such as querying the drivers, checking tachograph function etc?
- Who is responsible for accepting fuel deliveries?
- Is the fuel island well managed or is it untidy or congested?
- Does the pump dispense quickly enough?
- Does the fuel froth unacceptably?
- Is the fuel island on level ground?
- Is the island well lit and is it easy to read the pump readings?
- Have all drivers been briefed to fill vehicles to an identical level?
- Have agency drivers been briefed on fuel management procedures?

8.3 CLEANSING DATA

Unfortunately, no matter how carefully raw pump data is collected, it is rarely 100% accurate. Newer systems incorporate various checks to reduce the likelihood of keying errors. Without these, it has been found that up to 20% of transaction records collected automatically from a fuel pump system can be inaccurate.

To help reduce operator errors, make sure you have strong driver disciplines in place, particularly with regard to fuelling up vehicles.

Errors in odometer readings are usually corrected later by reference to the next reading. On the other hand, errors such as missing or mis-keyed fuel data will not be corrected unless the error is spotted and can be rectified manually.

Apart from using an outside bureau to check the raw data for you, the only real alternative is to check every transaction (ie the fuel performance based on the fuel drawn compared with the distance travelled since last fill) and review every result which is outside a norm of, say 25%, from the average performance. You can use a simple spreadsheet to undertake this task.

Provided the fuel recording system is working and set up correctly, the number of litres dispensed and the date/time should be recorded without problem. Errors creep in when the odometer reading has to be entered manually, or where the incorrect identification has been used for the vehicle or driver.

Newer systems can deal with this by automatic mileage download (such as a radio data link download taking information from the tachograph) and automatic vehicle and driver recognition. Most systems can be set up to estimate odometer readings and query those that fall outside a predetermined range. This will often detect common errors, such as simply transposing two digits of the odometer reading.

If the vehicle's fuel performance is occasionally much better than expected, this may be due to the vehicle fuel tank not being filled completely because the driver knows he is 'only doing a local run tomorrow'. As mentioned earlier, only clear procedures and good disciplines will prevent this. The next entry should compensate for this and show a worse than usual figure. However the two together would give a 'usual' result. This is referred to as a 'compensating error'. Sometimes it may be a considerable period of time before the tank is next filled fully and 'compensating errors' eliminated.

Exception reports will help to identify those drivers not carrying out the procedures properly and will help the Fuel Champion to take measures to eliminate these problems.

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8.4 DATA ANALYSIS AND REPORTS

Historical fuel information is valuable when preparing budgets or making 'same time last year' comparisons. It is recommended that fuel information for each vehicle at raw data level is kept throughout its life, in much the same way as its servicing records. (It may also help when selling the vehicle because it is evidence of its fuel performance and your thoroughness.) If it is not feasible to keep that much information, aim for a minimum of a rolling two-year period.

Standard reports

The following reports are recommended:

- bulk tank stock reconciliation;
- individual vehicle and driver fuel performance;
- exception reports.

Vehicle performance can then be grouped by type, such as:

- articulated/rigid;
- gross vehicle weight;
- manufacturer/model;
- age;
- work done.

Driver performance can also be grouped, using categories such as shift, type of work and trained or untrained.

Usual periods for measurement are weekly, monthly and year to date.

Useful comparisons are against:

- targets;
- previous period(s) for the analysis of trends;
- same period last year;
- other depots, bearing in mind regional and operational differences;
- similar vehicles;
- industry averages eg road test reports, published cost tables.

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8.5 USING THE DATA

The section discusses how to best use the information, making sure that the right type of information goes to the right people in the organisation - the ones who are going to act on it. 'Paralysis by analysis' is to be avoided at all costs.

The senior management will probably want a concise overview and will be particularly interested in the financial aspect. The transport manager (or Fuel Champion) will have to manage the fuel-saving initiatives, investigate specifics and carry out individual performance reviews. The driver trainer will need to plan a fuel-related training programme and set up discussions with drivers, who themselves need to start monitoring their own performance. Finally, engineering and maintenance staff will need to monitor and analyse the fuel figures.

Summaries and exception reports that show variances outside an agreed range are essential for the busy manager, focusing attention on the critical areas. Graphed reports are also very good for spotting trends and exceptions.

Investigate all unusual figures in exception reports. Remember there may be compensating errors which may account for the anomalies.

Some examples of typical reports are shown in Appendix 8B.

8.6 GOOD AND BAD PERFORMERS

Analysing the good and bad performers may be a time-consuming process and requires skill to do well, so the Fuel Champion must be prepared to devote time to it.

A good starting point is to identify the best and worst performing vehicles and drivers in the fleet over the last month. If the fleet is a large one, focus on a few at each end of the scale to avoid swamping yourself in too much detail.

Then try to identify the underlying cause; is it the driver, the vehicle or the type of work and the route? Switching vehicles, drivers and work could be considered as a way to help to confirm the diagnosis.

Vehicles appearing to be identical may give different fuel performance. Using 'Effectiveness Analysis' (see Appendix 8C) may enable you to improve the overall fuel performance of the fleet.

If the vehicle is the cause, attempt to identify any significant variances between the best and worst vehicles, such as vehicle type, specification, age or servicing history. Then decide if the differences can be eliminated or whether the poor performers have hidden defects that need investigating.

When all these avenues have been explored and feasible steps taken, a worthwhile tip is to use the most effective vehicle to carry out the trips that use the most fuel. This process is known as 'Effectiveness Analysis'. An example is contained in Appendix 8.C.

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If the driver is the cause, consider advice, coaching or a more formal driver development programme to develop fuel efficient driving techniques.

If the type of work turns out to be the cause of poor fuel consumption, at least this will help in future budgeting, contract negotiation and planning. It may point to a change in future vehicle specification or to a new strategy, using specific vehicles for a particular type of work.

It may be that certain trailers or loads give poorer figures - the trailer may need added maintenance or replacement. Some routes may need careful evaluation to see whether it is better to choose a longer, easier route thereby saving fuel overall. On-board computers (OBCs) are a useful aid in testing this.

The more you understand about how the factors (see Section 6) affect your operation, the more you can control them, compensating for the adverse and emphasising the positive.

8.7 SETTING KEY PERFORMANCE INDICATORS (KPIs) AND TARGETS

Section 5 discussed the use of Monitoring and Targeting techniques and referred to a number of guides available free from the Helpline. Once you have good quality data about your operation, you can consider embarking on this process.

There are many areas of fuel management which can be subject to key performance indicators and targets. The easiest are where measurement is straightforward and unaffected by too many outside factors. Examples would include bulk tank fuel losses where the figures might be measured each week with a requirement to investigate and resolve any losses over a target figure.

More complicated measures are involved in Monitoring and Targeting vehicle performance. The simplest way is merely to take current performance and demand an improvement. However, this takes into consideration only what has actually been achieved rather than what is achievable.

Where the routes, loads etc are consistent, it may be possible to set up standard targets by route, using your best driver to set the target for everyone else, although obviously, this will not take into account seasonal and other such outside influences, and therefore will need to be interpreted very carefully.

A more sophisticated approach is to use Energy Intensity as an indicator. For freight transport this is defined as (fuel consumed)/(tonnes carried x distance travelled) and would normally be measured as litres per tonne kilometre.

Heriot Watt University has carried out various studies in this area. A guide - ECG 76 *Benchmarking Vehicle Utilisation (Key Performance Indicators)* - can be obtained free of charge from the Helpline.

This area can become extremely complex and is beyond the scope of this Guide. It is therefore recommended that you start with simple targets and KPIs, understanding their limitations, and develop your own measures appropriate to your specific business.

APPENDIX 8.A SUGGESTED DRIVER DAILY WORK REPORT

Operational data as appropriate

Odometer (km/mile)

Closing	
Opening	
Distance	

Fuel Drawn (litres)

On-site	
Off-site	
Total	

Formula for calculating mpg:

If odometer in kilometres: multiply the number of kilometres by 2.825 and then divide by the number of litres.

If odometer in miles: multiply the number of miles by 4.546 and then divide by the number of litres.

_______________ X _______________ / _______________ = _______________s

(2.825 or 4.546) (km or miles) (litres) mpg

Note any unusual occurrences e.g. poor weather, heavy traffic, roadworks, diversions, vehicle breakdowns:

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APPENDIX 8.B EXAMPLES OF TYPICAL REPORT FORMS

1 Introduction

The series of forms in this appendix consists of:

- exception report;
- detail monthly analysis;
- summary report for vehicles (by group);
- driver league table.

The forms refer to the same vehicle fleet allowing you to see how they follow on from each other and also refer back to the initial data capture forms shown earlier (see Fig 7.3 and Fig 7.4) with the highlighted figures flowing through the system.

2 Example 1 - Exception report

To save the Fuel Champion working through the detailed entries, exception reports can be used to highlight all entries where the consumption is outside an acceptable range.

The exception report in this case has been set at 25% variance above or below the target mpg for each vehicle. Each of the exceptions identified should be cross-referenced back to the detailed monthly analysis to try to identify the cause of the problem.

Remember to adjust the target to allow for seasonal variances (see Section 6.5) and where the system allows, for other measurable variables. If you have sufficient historical data, you can look at the seasonal variation for your own fleet.

All these exceptions in the report should be thoroughly investigated to discover the reasons for the variances.

Remember to check first for compensating entries, eg where perhaps the first driver did not completely fill the vehicle.

This driver would get a good consumption and the next driver who does fill to the top of the tank would be penalised. Where driver league tables are used, these part-fills give erroneous figures, and the driver should be told and the results excluded from the tables.

Shorter distances often give poorer consumption results as they usually involve more stop/start work and may include a disproportionate amount of ‘depot work’ which generally gives poor fuel consumption.

In the example shown this could be the reason for the high variance and poor consumption.

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Poor weather, heavy loads, bad traffic etc are often the reason for a drop in performance. Where possible investigate. If the daily driver sheet allows for these circumstances to be recorded, refer back to them.

It is important to look for trends, so keep the monthly reports and see whether there is a pattern, eg the same driver in a particular vehicle on a particular job. Poor weather should give poor results for all vehicles on the same day.

3 Example 2 - Detail monthly analysis

Once a problem entry has been identified, the records for the vehicle should be checked in detail. This is best done at the level of data where you can see every fill-up for each vehicle (transaction data).

Obviously, if you are capturing the detail manually, you will have this level of detail. Most electronic systems will also give data to this level. Make sure you retain historical data at this level.

4 Example 3 - Summary by vehicle group

This is a simple analysis of vehicle monthly performance shown by vehicle grouping. These figures are ranked within group from best to worst relative to each vehicle's individual target.

Action can be taken to:

- understand why each vehicle has performed well or poorly.
- focus on either the driver or vehicle to make improvements.
- swap drivers, vehicles and work done to see the effect on consumption. This helps in establishing whether it is the vehicle or the driver affecting the result.

5 Example 4 - Driver league table

Driver league tables need to be introduced carefully as they are open to the criticism that at least part of the variations in performance are outside the control of the driver. For this reason, it may be necessary to develop them to allow for known fuel factors, eg route, load, time of day. Once you are satisfied that these tables give a reasonable picture of driver performance, you can consider what action can or should be taken eg selecting drivers for training.

In the example shown, the first driver, who was not a regular driver, had a return journey without a trailer, thus giving an exceptional result. (This entry can therefore be removed from the table.)

The last driver is from the workshop and helped out with a local delivery which involved a lot of urban driving. (This too can be removed from the table.)

On-board computer systems are usually capable of producing league tables. (See Appendix 2 for further information.)

EXAMPLE 1 - LIST OF EXCEPTIONAL ENTRIES (more than 25% from target mpg)

Monthly Analysis
01/02/00 to 29/02/00

Vehicle		Driver ID	Fill Date	Speedo reading (km)	Distance Covered (km)	Fill Qty (ltrs)	Fill Pt	Distance Kms	Metric Conversion			Consumption Performance		Code		
ID	Plate								Fill Qty (ltrs)	Average l/100 km	Target mpg	Actual mpg	Actual Variance	Excl DV	Error	Notes
14	D433MDP	05 Tim	19/02/00	234911	337	206.00	BD	337	206.00	61.13	7.96	4.62	-41.96%			
15	L438HPW	12 Barry	16/02/00	372688	46	22.30	BD	46	22.30	48.48	9.10	5.83	-35.9%			
17	G702FTP	05 Tim	23/02/00	64367	88	43.00	BD	88	43.00	48.86	8.09	5.78	-28.6%			
20	L661FPG	08 Chris	10/02/00	360145	182	50.00	BD	182	50.00	27.47	8.02	10.28	28.2%			
22	L416PYT	10 Tony	11/02/00	30532	127	13.00	BD	127	13.00	10.24	16.24	27.60	70.0%			{compensating}
22	L416PYT	99	12/02/00	30623	91	20.70	BD	91	20.70	22.75	16.24	12.42	-23.5%			{compensating}
22	L416PYT	03 Nigel	17/02/00	31147	210	59.20	BD	210	59.20	28.19	16.24	10.02	-38.3%			{compensating}
22	L416PYT	12 Barry	18/02/00	31232	85	10.00	BD	85	10.00	11.76	16.24	24.02	47.9%			{compensating}
23	N417KCX	01 Paul	04/02/00	223905	360	50.00	BD	360	50.00	13.89	15.19	20.34	33.9%			
24	K812AXT	13 Peter	03/02/00	762711	51	40.00	BD	51	40.00	78.43	7.60	3.60	-52.6%			
26	L817JTT	04 John	05/02/00	288417	231	32.00	BD	231	32.00	13.85	15.66	20.40	30.3%			{compensating}
26	L817JTT	04 John	06/02/00	288289	172	40.00	BD	172	40.00	23.26	15.66	12.15	-22.4%			{compensating}

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EXAMPLE 2 - VEHICLE DETAIL MONTHLY ANALYSIS

Company Name **01/02/00 to 29/02/00**

Driver ID	Fill Date	Speedo Reading (km)	Distance		Fill Point	Metric Conversion			Consumption Performance			
			Covered (km)	Fill Qty		Distance (km)	Fill Qty (ltrs)	Average l/100 km	Target mpg	Actual mpg	Actual Variance	Codes
Vehicle ID: 15	Plate: L438HPW											
07 Dave	03/02/00	370829	314	94.00	BD	314	94.00	29.94	9.10	9.44	3.7%	
07 Dave	04/02/00	371143	314	100.80	BD	314	100.80	32.10	9.10	8.80	-3.3%	
07 Dave	05/02/00	371457	314	106.00	BD	314	106.00	33.76	9.10	8.37	-8.0%	
07 Dave	06/02/00	371625	168	57.40	BD	168	57.40	34.17	9.10	8.27	-9.1%	
07 Dave	09/02/00	372018	393	126.30	BD	393	126.30	32.14	9.10	8.79	-3.4%	
07 Dave	10/02/00	372332	314	96.80	BD	314	96.80	30.83	9.10	9.16	0.7%	
07 Dave	11/02/00	372642	310	96.90	BD	310	96.90	31.26	9.10	9.04	-0.7%	
12 Barry	16/02/00	372688	46	22.30	BD	46	22.30	48.48	9.10	5.83	-36.0%	See exception report
07 Dave	16/02/00	372808	120	37.50	BD	120	37.50	31.25	9.10	9.04	-0.7%	
07 Dave	17/02/00	373085	277	96.00	BD	277	96.00	34.66	9.10	8.15	-10.4%	
07 Dave	18/02/00	373453	368	111.20	BD	368	111.20	30.22	9.10	9.35	2.7%	
07 Dave	19/02/00	373767	314	106.00	BD/OS	314	106.00	33.76	9.10	8.37	-8.0%	Includes 20 litres offsite
07 Dave	20/02/00	374082	315	103.00	BD	315	103.00	32.70	9.10	8.64	-5.1%	
07 Dave	23/02/00	374397	315	108.00	BD	315	108.00	34.29	9.10	8.24	-9.5%	
07 Dave	24/02/00	374713	316	109.00	BD	316	109.00	34.49	9.10	8.19	-10.0%	
07 Dave	25/02/00	375027	314	102.00	BD	314	102.00	32.48	9.10	8.70	-4.4%	
07 Dave	26/02/00	375341	314	101.00	BD	314	101.00	32.17	9.10	8.78	-3.5%	
07 Dave	27/02/00	375814	473	147.00	BD	473	147.00	31.08	9.10	9.09	-0.1%	
Summary For: 15	**Plate L438HPW**					**5299**	**1721.2**	**32.48**	**9.10**	**8.70**	**-4.4%**	

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EXAMPLE 3 - SUMMARY BY GROUP TYPE

Monthly Analysis 01/02/00 to 29/02/00	Metric Conversion			Consumption Performance			Code Notes
	Distance (km)	Fill Qty (ltrs)	Average l/100 km	Target mpg	Actual mpg	Actual Variance	
VEHICLE TYPE: 10a							
Summary for: 2 Plate: F904AJM	718	107.10	14.92	20.98	18.93	-9.8%	
Summary for vehicle type: 10a	**718**	**107.10**	**14.92**	**20.98**	**18.93**	**-9.8%**	
VEHICLE TYPE: 15a							
Summary for: 23 Plate: N417KCX	7660	1380.10	18.02	15.19	15.68	3.2%	
Summary for: 26 Plate: L802XPA	4345	789.00	18.16	15.66	15.57	-0.6%	
Summary for: 22 Plate: L416PYT	2379	424.27	17.83	16.24	15.85	-2.4%	
Summary for: 6 Plate: K57PNJ	3419	793.00	23.19	14.12	12.19	-13.7%	
Summary for vehicle type: 15a	**17803**	**3386.37**	**19.02**	**15.21**	**14.86**	**-2.3%**	
VEHICLE TYPE: 20							
Summary for: 30 Plate: S107EXJ	4357	987.70	22.67	12.1	12.45	2.9%	
Summary for: 32 Plate: P499YRV	6527	1455.00	22.29	12.75	12.68	-0.5%	
Summary for vehicle type: 20	**10884**	**2442.70**	**22.44**	**12.48**	**12.59**	**0.9%**	
VEHICLE TYPE: 25							
Summary for: 17 Plate: G702PTF	2911	994.00	34.15	8.09	8.27	2.2%	
Summary for: 24 Plate: K812AXT	5410	2008.50	37.13	7.60	7.61	0.1%	
Summary for: 9 Plate: L307UPJ	4816	1536.00	31.89	9.06	8.86	-2.2%	
Summary for: 25 Plate: L542XSP	6639	2417.00	36.41	7.98	7.76	-2.8%	
Summary for: 5 Plate: J311FPT	6366	2035.00	31.97	9.19	8.84	-3.8%	
Summary for: 16 Plate: H864FJX	5233	1790.00	34.21	8.62	8.26	-4.2%	
Summary for: 15 Plate: L438HPW	5299	1721.20	32.48	9.10	8.70	-4.4%	
Summary for: 20 Plate: L661FPG	7945	2949.00	37.12	8.02	7.61	-5.1%	
Summary for: 14 Plate: D433MDP	1346	570.33	42.37	7.96	6.67	-16.2%	
Summary for vehicle type: 25	**45965**	**16021.03**	**34.85**	**8.39**	**8.11**	**-3.3%**	

EXAMPLE 4 - DRIVER LEAGUE TABLE

Monthly Analysis SUMMARY 01/02/00 to 29/02/00

Driver ID	Driver Name	Metric Conversion			Consumption Performance			Code Notes
		Distance (km)	Fill Qty (ltrs)	Average l/100 km	Target mpg	Actual mpg	Actual Variance	
03 Nigel	Nigel Apple	460	112.00	24.35	9.06	11.61	28.1%	
11 Patrick	Patrick Blaine	353	120.50	34.14	7.60	8.30	9.2%	
15 Owen	Owen Straws	6472	1143.60	17.67	15.48	15.98	3.2%	
19 Francis	Francis Sargent	6893	1231.09	17.86	15.37	15.81	2.9%	
05 Tim	Tim Dinsdale	2911	994.30	34.16	8.09	8.27	2.2%	
13 Peter	Peter Difford	4459	1632.70	36.62	7.60	7.72	1.6%	
22 John	John Blitz	6527	1455.40	22.29	12.75	12.68	-0.6%	
04 John	John Wedgwood	6639	2417.10	36.41	7.98	7.76	-2.8%	
07 Dave	Dave Arthur	6178	1888.60	30.57	9.24	8.95	-3.1%	
09 Doug	Doug McCollum	3789	1256.30	33.16	8.86	8.53	-3.7%	
10 Tony	Tony Hosford	6366	2035.00	31.97	9.19	8.84	-3.8%	
08 Quentin	Quentin Fox	7705	2860.20	37.12	8.02	7.61	-5.1%	
14 Johnny	Johnny Sussman	1006	337.40	33.54	9.06	8.43	-7.0%	
02 Pete	Pete Willcox	718	107.10	14.92	20.98	18.93	-9.8%	
99	Agency Drivers	304	134.50	44.24	7.60	6.39	-15.9%	
12 Barry	Barry Thompson	95	42.10	44.32	9.06	6.39	-29.5%	

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APPENDIX 8.C EFFECTIVENESS ANALYSIS (EA)

Once the fuel consumption data has been brought up to a good standard it will be possible, where more than one vehicle is being used, to identify which are the most fuel-efficient vehicles. By placing the most fuel-efficient vehicles on the longest routes, improvements can be made in fleet fuel efficiency without spending any extra money. First, it has to be determined that it is the vehicle and not the driver that makes the difference. Interchanging drivers, vehicles and routes for short periods of time can do this. An example of this, how it was applied, and the savings generated, is given below.

A particular fleet includes three 38-tonne units that undertake three overnight trunk runs. One of these units is used during the day to take on an additional trunk run. The remaining two units are occasionally used for local delivery work. Analysis of the tachograph charts indicated that the distances for the four trunk routes were:

Route 1 - overnight trunk of 300 miles.

Route 2 - overnight trunk of 350 miles.

Route 3 - overnight trunk of 410 miles.

Route 4 - daytime trunk of 300 miles.

The traffic department assumed that because the units were identical models and were of a similar age that they would produce the same fuel consumption. Production of accurate mpg figures revealed that the average mpg for the three vehicles was Unit 1 - 7.3 mpg; Unit 2 - 7.15 mpg; Unit 3 - 6.5 mpg.

Before applying EA to the fuel costs, Unit 3 was used on routes one and four, Unit 2 on route three and Unit 1 on route two. The average daily fuel usage is shown in Fig 8.1.

Fig 8.1 Average daily fuel consumption

Unit & mpg	Route	Distance - Miles	Fuel Used – Gallons
1 – 7.3	2	350	47.95 (350/7.3)
2 – 7.15	3	410	57.34 (410/7.15)
3 – 6.5	1 & 4	600	92.31 (600/6.5)
Daily Fuel Usage			**197.60**

Source: Transport & Logistics Research Unit: University of Huddersfield (1999)

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Interchanging drivers, vehicles and routes determined that the fuel consumption figures were more sensitive to the vehicle than the driver or route. By assigning the vehicles with the best fuel consumption to the longer trunk runs, fuel consumption was reduced, as shown in Fig 8.2.

Fig 8.2 Reduced fuel consumption

Unit & mpg	Route	Distance (Miles)	Fuel Used (Gallons)
1 – 7.28	3 & 4	710	97.53 (710/7.28)
2 – 7.15	2	350	48.95 (350/7.15)
3 – 6.6	1	300	45.45 (300/6.6)
Daily Fuel Usage			**191.93**

Source: Transport & Logistics Research Unit: University of Huddersfield (1999)

The daily fuel saving was 5.67 (197.60 - 191.93) gallons. Applying a fuel price of £2.83 per gallon, operating five days per week for 50 weeks per year, an annual saving of £4,000 is produced. Route four involved the most hill work and therefore accounted for the slight change in consumption figures when it was reallocated to Unit 1 from Unit 3.

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Checklist

Section	*Things to do*	*In place*	*Done*	*Not appropriate*
8.1	Collect and retain raw, not 'mpg', data, in a database or spreadsheet	☐	☐	☐
8.2	Review current arrangements for collecting data	☐	☐	☐
8.2	Review/amend systems to identify, eliminate or correct known errors in the data	☐	☐	☐
8.2	Capture all off-site refuelling accurately. If fuel cards are used, investigate electronic download of data	☐	☐	☐
8.2	Get drivers to calculate their own mpg (eg on daily sheets)	☐	☐	☐
8.3	Check and clean up fuel data. Identify and rectify causes of messy and inaccurate data to reduce effort required	☐	☐	☐
8.4	Review fuel reporting procedures for appropriateness	☐	☐	☐
8.5/ 8.6	Review what you use the information for and the value you get from it	☐	☐	☐
8.7	Make best use of data by establishing relevant KPIs and targets for measurement of performance	☐	☐	☐

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9.1 INTRODUCTION

Time spent in evolving the best specification for a vehicle is time well spent. The right specification will often cost little or no more than the wrong specification but will save money throughout the life of the vehicle. It is worth remembering that the capital cost is usually less than half of the whole life cost.

Choosing the size and type of vehicle that is right for the job is one of the first steps on the path towards optimum fuel management.

To put it another way, in two years a typical tractive unit will use diesel that costs much the same as the vehicle's purchase price. What is more, the value of a fuel-efficient specification will increase as diesel fuel becomes more expensive.

Attention must also be given to the load-carrying part of the vehicle, whether it is a trailer or the body on a rigid vehicle. It will generate considerable aerodynamic drag and so will be a major influence on fuel economy. It will also have an impact on a vehicle's overall productivity and ease of operation. A specific Guide on the use of aerodynamic equipment - *Truck aerodynamic styling* (GPG308) is available from the Helpline and on-line from: www.energy-efficiency.gov.uk/transport

This section considers vehicle specification from the point of view of fuel performance, although inevitably wider issues are mentioned too.

9.2 THE BASICS

The following are some of the basic points, not necessarily related to fuel, which should be established when buying new vehicles:

- Is there a good dealer nearby?
- Is there an adequate dealer network covering the routes that your vehicles will travel?
- Is the vehicle available in a configuration, wheelbase length and with an engine power output option to suit your needs?
- Do you need a sleeper cab and is the cab the right size?
- How heavy is the vehicle when it is unladen?
- Is maintenance going to be competitively priced and convenient, whether maintained by the dealer, in-house or by another contractor?
- What are the service intervals?

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- Does the manufacturer allow extended oil drain intervals dependent on the type of operation and the type of oil used?
- Is the engine fully electronically managed, and able to allow fuel consumption and engine data to be captured and downloaded?
- What fuel tank capacities can be fitted?
- Are fuel tanks fitted on the 'right side' for your fuel islands, and if you are running refrigerated trailers, are they all compatible?

9.3 WHOLE LIFE COSTING

Although it is easy to focus on capital cost when choosing vehicles, this should not be the only factor taken into account. Instead, make choices based on whole life costs that include the cost of financing the purchase, operating costs (primarily fuel and maintenance) and depreciation (based on anticipated residual value) and the anticipated residual value itself.

It is beyond the scope of this Guide to explore whole life costing in detail. If necessary, take advice from an accountant to make sure that the full cost implications are considered. This will allow the use of sophisticated techniques such as discounted cash flow if necessary. The use of discounted cashflows is particularly important when evaluating the worth of residual values, and especially in deciding whether it is worth investing in additional options to enhance the second hand value of the truck.

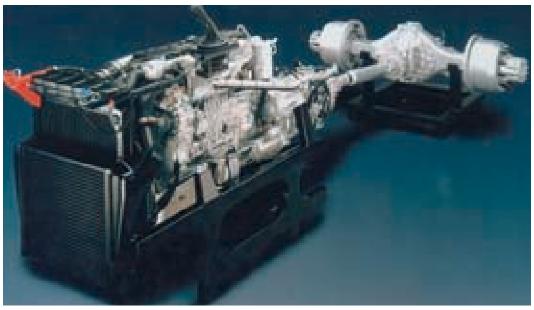
A vehicle that is too highly specialised may be difficult to sell.

Consider the future resale of the vehicle, but do not go overboard for too much power in an attempt to enhance its resale value; the fuel bill may wipe out any anticipated savings.

9.4 DRIVELINE SPECIFICATION

Matching the engine output (in terms of both power and torque) to the gearbox ratios and the drive axle ratio is absolutely essential for optimising fuel consumption. Equally, the overall specification has to be suited to your operation, so that the engine is working in its most fuel-efficient speed range for as much time as possible.

Studying engine performance curves that show power, torque and brake specific fuel consumption plotted against engine speed will tell the fleet engineer much about the suitability of a particular specification to their own operation.



It is worth exploring the engine, gearbox and axle-ratio options available to arrive at the best driveline for the task.

In general terms, you should choose high power engines and higher final drive ratios for long distance work. Vehicles that will spend most of their time on local work will generally be more economical with less power than that needed for longer distances, fewer gear ratios and a lower final drive ratio.

To help operators with choices about drivelines, gearbox ratios etc, most manufacturers have computer programs that can compare the various options of engine, gearbox and final drive ratio. The program will forecast the vehicle's theoretical performance, including fuel consumption. You can help ensure that the program arrives at the right answer by supplying as much accurate information as possible about your operation. Then try to obtain a demonstrator vehicle that is as close as possible to this specification.

When buying a used vehicle, its exact power rating or final drive ratio may not be apparent and it is possible to make an expensive mistake. For example, it could have a long-distance specification (high power and a high final ratio), making it relatively uneconomical for local work.

If the seller cannot produce evidence of the exact specification, it is worth quoting the chassis number to the franchised dealer; this should give access to the manufacturer's original build specification.

CASE STUDY

Engine/Driveline Specification BOC

BOC had been collecting and analysing data downloaded from the Cummins Road Relay onboard management system. They found that these data held the key to identifying the reasons why some drivers were far more efficient than others.

For example, a driver holding top gear for 87% of the distance and using cruise control for 89% of the journey would use 21% less fuel than a driver who was in top gear for 71% and in cruise control for 25% of the same route and driving the same vehicle. This is illustrated in Table 1.

Table 2 illustrates the fuel consumption benefits through the reduction of over-revving the engine.

BOC concluded that the best driving practice for fuel efficiency is to keep the Cummins engines' rpm below the 1,700 'sweetspot' limit. Above this sweetspot, which was at the top of the green band, 'was like turning up the fuel tap', he said. The sweetspot is the optimal (minimum) Specific Fuel Consumption for a given engine power and speed.

Table 1 Fuel efficiency improvement of 21.4% through maximising use of top gear and cruise control

Fleet No.	Miles	Gallons	mpg	% distance in top gear	% distance using cruise control
4505	9560	1201	7.96	71	25
4505	9996	1035	9.66	87	89
Difference			1.7 (21%)	16	64

Source: Huddersfield University

Table 2 Fuel efficiencies through the reduction of over-revving

Fleet No	Engine Revs	Miles	Gallons	mpg
4547	Allowed to go above 1,700 rpm	12687	1515	8.4
4547	Kept below 1,700 rpm	12942	1484	8.7
Difference				0.3 (3.5%)

Source: BOC

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Finally, a word of warning for those acquiring vehicles through contract hire or operating lease. The best vehicle for the task in hand may be, for instance, a low-power tractive unit with a day cab, and yet the monthly lease payment is lower for a more powerful unit with a sleeper cab.

This is mainly a reflection of the desirability of the vehicle in the used market at the end of the lease term. It is important to consider the difference in fuel costs between the two specifications – saving £20 a month on the lease rate may cost £40 a month in fuel.

9.5 ASSESSING A DEMONSTRATOR VEHICLE

The driver should be shown how to get the best out of the vehicle during the short time it is with you. If there were a large difference between the computer-predicted fuel consumption and the actual figure achieved, it would be a good idea to re-run the computer forecast using the demonstrator's actual specification to see if the difference in specification could be the reason for the variation. Remember to check issues such as tachograph recording accuracy etc.

If all the other operational data are correct, it is reasonable to assume that the computer model is inaccurate for your operation and so the actual results achieved must be your guide. It may be necessary to make an allowance for external factors (discussed in Section 6), such as the weather conditions during the demonstration period.

9.6 BODYWORK AND AERODYNAMICS

A small body is lighter, stronger and less liable to be damaged than a large one. It creates less drag and so fuel consumption will be better than if a bigger body was fitted. The best size of body will normally be the smallest one necessary to do the job (allowing for future changes), not the biggest that can be bought for the money.

Fitting an air deflector on the cab roof will minimise the drag of a high body but the air deflector has to be paid for in the first place. Equally, cab-side deflectors help streamline a body that is wider than the cab, but it is worth checking that the body really does need to be that wide – many people opt for a full-width body without question.

Aerodynamic aids are not necessarily add-on extras. For example, it is advisable to specify bodies with rounded edges, with a radius of about 200 mm. This will improve fuel consumption and also help stability in crosswinds. The extra cost of this detail is spending money wisely rather than spending additional money.

A light box-bodied vehicle on regular high-speed work would turn in a significantly better fuel performance if it had some aerodynamic assistance.

Not all money spent on aerodynamics is necessarily a good investment. Aerodynamics become more important as speed rises, so a vehicle that spends its life making urban deliveries close to base may never repay the cost of an add-on aerodynamic package. If you have an operation that largely involves urban transport, it may be worthwhile to run some trials to check the costs and benefits achieved with your operation.

Conversely, the most suitable candidate for attention to its aerodynamics is a light vehicle with a large body, spending a lot of time on the motorway and trunk roads, which permit relatively high speeds to be maintained. Because of its low weight but large dimensions, wind resistance will feature prominently in the total forces that need to be overcome to keep the vehicle moving.

Appendix 9.A contains details of some case studies on the effectiveness of aerodynamic aids.

Curtain-sided bodies are inherently slightly less aerodynamically clean than smooth-sided box vans because the curtains are less rigid and the air flow is broken up by the curtain buckles and the pelmet. To mitigate these effects, the curtains should be tightly tensioned. Some organisations have stated that buckleless curtain-siders have improved their fuel performance.

An important aspect is minimising the coupling gap between the tractive unit and the trailer, restricting the amount of air resistance encountered by the trailer's front bulkhead. Many of the air management kits fitted to tractive units have side pieces that are designed to partially fill the gap.

A simple, square-edged box body with no aerodynamic aids may be an inexpensive specification to buy but it makes little concession to future fuel bills.

This truck has been specified with an eye to optimising its aerodynamics, with a small body that is well-matched to the air-kit. The radius on the body edges will help too.

A test carried out in 1999 as part of the British Transport Advisory Committee/Institute of Road Transport Engineers technical trials found that sheeting an empty tipper body could produce some worthwhile fuel savings.

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When setting the position of the tractive unit's fifth wheel to determine the coupling gap, there are several considerations to bear in mind.

- There must be adequate swing clearance for the trailer when the vehicle is articulated, including an allowance for vertical articulation such as on ramps when the top of the trailer is closer to the back of the cab.
- There must be room for the driver to be able to reach the air-lines and electrical connectors in order to connect and disconnect them.
- The tractive unit may have to pull a variety of trailers with different kingpin settings, so the fifth wheel must either cater for the deepest kingpin position or be adjustable.
- The fifth-wheel position will determine the weight distribution on the tractive unit – moving it further forward to minimise the cab gap will increase the loading on the steer axle and reduce the load (and traction) on the drive axle.

The buckles and straps on curtain-sided bodywork cause a small amount of drag, but there needs to be thorough testing to prove that buckleless bodies can demonstrate a measureable fuel saving.

The vehicle coupling gap and the vertical ribbing on the container will inevitably make the aerodynamics of this combination far from perfect. A sliding fifth wheel could be adjusted to close-up the gap.

- The overall length of the outfit must always conform to the legal maximum.
- There are legal limits on maximum axle weights.

Similar issues apply to the position of the body on a rigid vehicle. Mounting it as close as possible to the back of the cab is preferable for good aerodynamics, but the issues of weight distribution and clearance for cab tilting need to be thought through. In 2002 the Energy Efficiency Best Practice Programme published *Truck aerodynamics styling* (GPG308), available free of charge through the Helpline and on-line from: www.energy-efficiency.gov.uk/transport

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9.7 AXLES AND TYRES

The more tyres a vehicle has in contact with the road, the greater the rolling resistance and the higher the fuel consumption. This is particularly true when the axles are not tracking parallel to the direction of travel and when tyres are under-inflated.

The scrub on the tyres on the rearmost axle of a tri-axle trailer during a tight turn demonstrates this well – the energy required to scrub the tyre as it is dragged sideways is derived from fuel being consumed.

Self-steering axles at the rear of trailer bogies and at the back of three-axle vehicles have become popular in recent years to reduce tyre scrub when the vehicle manoeuvres regularly in confined spaces.

They may pay for themselves in better manoeuvrability, longer tyre life and marginally better fuel consumption. Lifting axles that lift the wheels clear of the road when the vehicle is running empty or lightly laden serve the same purpose.

Tyre manufacturers have been striving to reduce the rolling resistance of tyres in order to promote their fuel-saving benefits. A tyre's rolling resistance decreases naturally as its tread depth reduces, but to produce a new tyre with low rolling resistance without reducing the tread depth is much more difficult.

The validity of claims for tyres advertised as 'energy efficient' needs to be carefully considered. The savings are most likely to be apparent if the vehicle has multiple axles (such as a five- or six-axle artic), it is engaged on long distance trunking and all axles are fitted with the low-rolling resistance tyres.

Although positively-steered rear axles like this are primarily specified to improve manoeuvrability, reducing tyre scrub will also conserve energy and hence improve fuel performance.

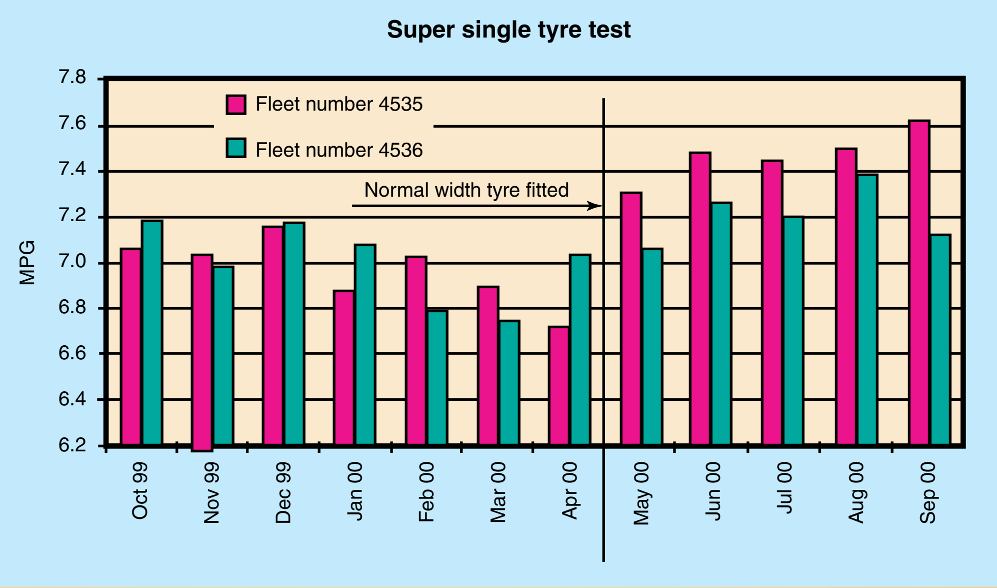
Some operators have switched to wide single-steer tyres such as 385/65R22.5 size because they last longer than standard 295/80R22.5 tyres. But their greater rolling resistance is said to lead to a theoretical deterioration in fuel consumption on a five axle articulated vehicle of 1.5-2.0%.

In other circumstances, improvements in fuel consumption may not be so significant, and in any event, there may be deterioration in other aspects of tyre performance. Tyre compounds and designs are a delicate balancing act between such factors as rolling resistance, wear rate, grip, abrasion resistance, noise, casing life, cost and weight. Accentuating one of these features can impact on the others.

CASE STUDY

Tyres BOC

BOC Gases noticed that two new vehicles were struggling to meet their fuel consumption targets. They discovered that they were fitted with wide single tyres on the steer axle. By reverting to standard width tyres, fuel consumption was improved by an average of 0.51 mpg or 3.6%. Both vehicles have now bettered their route targets, and are providing an annual fuel saving of £1,900 per year. The bar chart not only shows the immediate improvement in fuel consumption after the standard width tyres were fitted.



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APPENDIX 9.A AERODYNAMIC AIDS

Savings produced through the use of aerodynamic styling kits or aids can be quite substantial, though these savings are highly sensitive to road speed. The higher the speed the greater the saving. Where vehicles spend a great deal of their operational distance at low speeds the aerodynamic aids may not have a significant effect.

In 2002 the Energy Efficiency Best Practice Programme published *Truck aerodynamics styling* (GPG308), available free of charge through the Helpline and on-line from: www.energy-efficiency.gov.uk/transport, providing technical information about all aspects of the subject.

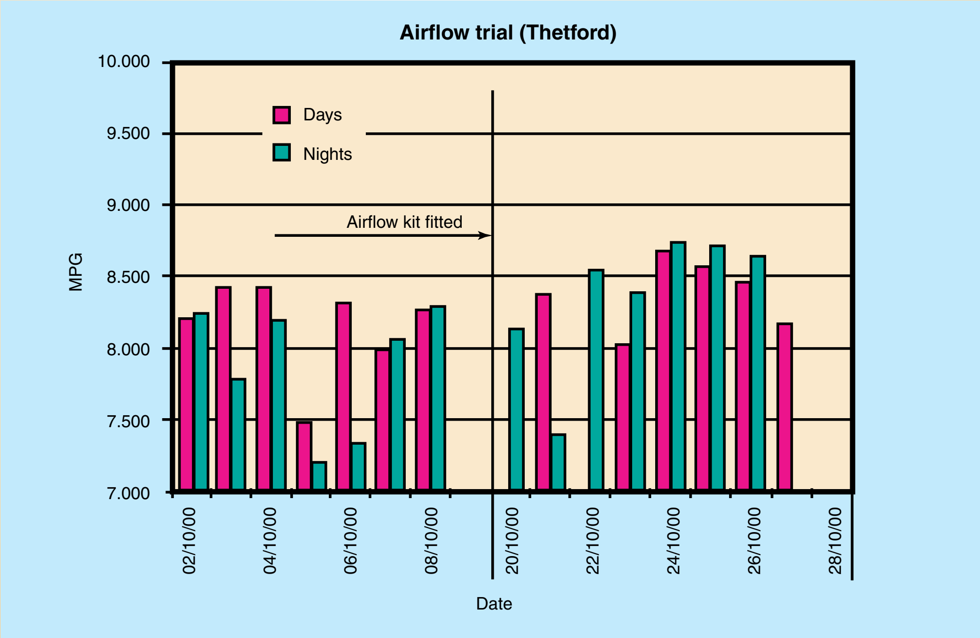
CASE STUDY

Aerodynamics - BOC

An AB Air Flow Deflector kit was fitted to an ERF equipped with a sleeper cab which ran day and night on long distance, motorway trunking runs. The vehicle was driven by the same four drivers and based at BOC's Thetford branch.

The bar chart illustrates not only a 4% improvement in fuel consumption of an already efficient 41 tonne vehicle, but also how the benefits are usually greater when the vehicle is running at night. This is because of the longer period that the vehicle can run at the maximum regulated speed of 56 mph.

All the data from the trial were carefully monitored by the Logistics Research Unit at Huddersfield University and indicate a 4% improvement in fuel consumption and a financial payback of five months.



Transport operators must remember that the savings are highly sensitive to road speed and large goods vehicles that travel a high proportion of their distance at speeds below 40 miles per hour (mph) will see much less improvement in fuel consumption.

It is generally accepted, as a rule of thumb, that at speeds below 30 mph there are no savings to be made through the use of aerodynamic aids. Figure 9.3 shows the results of an aerodynamic test that was conducted at the 1999 British Transport Advisory Committee (BTAC) Technical Trials, under the auspices of the Institute of Road Transport Engineers (IRTE).

Fig 9.1 The sensitivity of aerodynamic aids to road speed.

		Aerodynamic Intervention Not Applied	Aerodynamic Intervention Applied	
Speed (mph)	Distance (miles)	Consumption (mpg)	Consumption (mpg)	Difference
37	13.914	14.25	14.48	1.6%
50	13.914	9.35	10.10	7.5%
56	13.914	8.58	9.46	9.3%
Average		10.21	10.96	6.8%

Source: Transport Engineer, August 1999 - Aerodynamic aids

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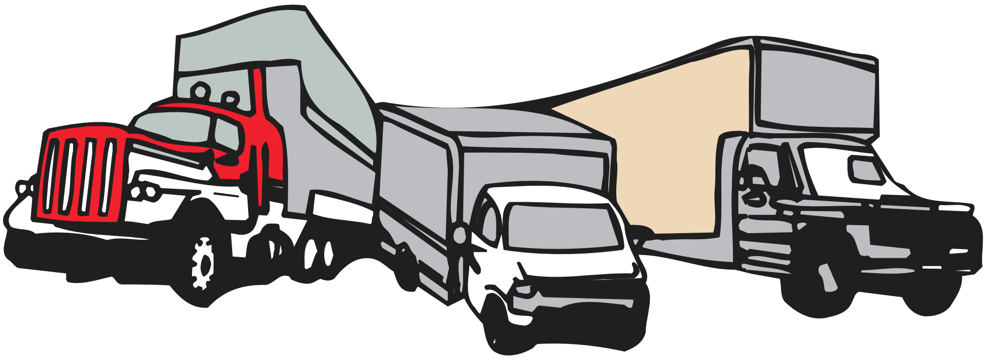
Checklist



Section	*Things to do*	*In place*	*Done*	*Not appropriate*
9.1	When purchasing make sure you give sufficient time and thought to vehicle specification	☐	☐	☐
9.4	Use manufacturers' IT systems to help optimise specifications	☐	☐	☐
9.4	On used vehicles, check driveline and powertrain are suitable	☐	☐	☐
9.5	Ask for a demonstrator to confirm manufacturers' fuel predictions	☐	☐	☐
9.6	Consider alternative options to standard specifications	☐	☐	☐
9.6	Specify bodywork carefully to ensure it is right for the job	☐	☐	☐
9.6	Make sure the aerodynamic specification is appropriate for your vehicle and read GPG308	☐	☐	☐
9.7	Consider self-steering/lifting axles. If tyre scrub is a problem, remember that there is a trade-off between tyre costs, fuel costs, capital costs and loss of payload	☐	☐	☐

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10.1 INTRODUCTION

Maintenance policy has to be governed by safety, the requirements of the Operator's Licence and the vehicle manufacturer's recommendations (which will affect the warranty). However, overall vehicle performance, including fuel consumption, is also a reflection of the quality of the maintenance, so it is important to integrate awareness of fuel economy into the subject of maintenance.

It is beyond the scope of this Guide to go into great depth on this subject. Maintenance procedures are normally available from vehicle manufacturers. However the following are some points to be taken into account.

A number of points for drivers are included - while it will normally be the responsibility of transport management to brief drivers, they may need assistance from maintenance managers to ensure they understand the reasons behind the points to be made.

10.2 RECORD KEEPING

The maintenance department should keep a record of vehicle fuel consumption history to help spot trends or changes. If a dealer or an external workshop carries out maintenance, it is worth including a fuel consumption record with the vehicle when it goes for service. Failing that, the person responsible for fuel recording should check the figures and pass on the information.

That person should also be able to reconcile the vehicle maintenance records with the fuel consumption history and see if there are any substantial changes after services. Monitoring service records can help identify driver issues that also influence fuel performance. For example, early replacement of brake linings or pads may indicate poor forward planning while driving.

10.3 GETTING THE PRIORITIES RIGHT

Particular care should be taken to ensure that maintenance is based on the right mix of cost and fuel performance, particularly if maintenance is contracted out.

Whether maintenance is carried out by in-house workshops or contracted out, you may wish to consider having someone independent from the maintenance function to run spot checks of the maintenance records.

These should cover issues such as intervals between services, the two-year tachograph check records and the overall completeness of the service history. It may be appropriate to use

Make sure that maintenance is based on the right mix of cost and fuel performance.

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outside auditors to check workshop procedures and vehicle maintenance standards. The Operator's Licence hinges on these issues.

Remember that just because an item has been 'ticked', it does not necessarily mean that it has been checked, repaired or replaced. An example of this is checking tyre pressures, and in particular 'inner wheel' tyre pressures.

Workshop safety is another consideration for those with in-house maintenance; external health and safety consultants can provide an objective and impartial assessment.

10.4 TURBOCHARGERS

Most modern diesel engines are turbocharged and if the turbocharger is not working correctly there will be a deterioration in power. This in turn will result in the engine using more fuel for a given level of performance.

The turbocharger's shaft can be spinning at up to 120,000 revs per minute and depends on a constant oil supply to keep it lubricated. Switching an engine off immediately after a run will stop the oil supply, even though the turbocharger's shaft is still spinning, as it takes a while to slow down. It is therefore good practice to let an engine idle for a minute or two after pulling in – the vehicle's handbook should give the manufacturer's exact recommendation.

10.5 DRIVER'S VEHICLE CHECK

Drivers should already carry out safety checks at the beginning of their shift or when they swap vehicles or trailers. A conscientious driver will also do a quick walk-round check at the end of a rest break to check the security of the load and to see there are no leaks of fuel, air, oil or water. These may only show up when the vehicle has been standing while it is hot. Some example checklists can be found in Appendix 11C.

Fuel leaks such as those from pipe unions or where a tank has been chafing on the straps are an obvious but common cause of poor fuel performance. They can also harm the environment because they may find their way into the surface water drainage or the water table.

Air leaks from the vehicle's pressurised air system will also have an indirect impact on fuel consumption. Any air that leaks out will have to be replaced by the compressor, driven by the engine. Engine power to drive the compressor simply to replace the leaking air is not being used to drive the vehicle and so is wasteful.

Oil leaks are both a maintenance and safety issue and also indicate a fault on the engine which may well be affecting fuel performance.

10.6 SMOKE MONITORING

Drivers should be encouraged to check for the presence of exhaust smoke from their vehicles, noting the colour of the smoke and reporting it to those responsible for maintenance. Persistent smoke of any colour normally indicates that fuel is being wasted because the engine is not at its optimum.

Black smoke is usually caused by unburned carbon (from the fuel) in the exhaust. Although the specification of the fuel has a great deal to do with this, so does the engine's injection and combustion set-up. Over-fuelling will produce black smoke, so incorrect injection pump calibration or worn injectors are common causes. A dirty air filter will have a similar effect.

White smoke is a mixture of unburned fuel droplets combined with water. It is typical when a diesel engine starts from cold and the temperature is still too low for evaporation and complete combustion. It should disappear when the engine is warmed up.

If the smoke has a blue tinge to it, this suggests that there is oil getting into the combustion chambers. This could be due to a piston ring or valve problem, or simply a worn engine.

You may wish to consider the cost-effectiveness of periodic engine tests. These would include a compression test, injection pump calibration and checking the injectors. To assess the value of doing this, it is a good idea to run the checks on a small sample of vehicles and see if they consistently perform better than the rest of the fleet.

This underlines the importance of the maintenance department having access to the vehicle fuel performance records. The fuel consumption figures may well show up a minor problem before the driver notices it.

10.7 FUEL INJECTION SYSTEM

As the vehicle gets older, and its engine starts to wear, you can expect wear of the fuel injection system. Recalibration by a specialist may improve fuel performance by up to 5% and may identify more serious faults.

10.8 TYRE CHECKS

Maintaining correct tyre pressures is known to be the best way of maximising the life of a tyre. Establishing the optimum pressure – which entails knowing the maximum regular axle loading - and then maintaining that pressure will also help the vehicle's fuel consumption. Tests have found that 20 per cent under-inflation will cause a 10 per cent increase in rolling resistance, leading to a two per cent deterioration in fuel consumption on average.

Keeping tyre pressure as close as possible to the recommended level for the load they are carrying is a proven way of optimising both tyre life and fuel performance. The rolling resistance of the tyre will reduce slightly as the tread wears.

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Tyre pressures should be checked with the tyres at ambient temperature. A visual inspection is an essential part of a driver's daily checks. Missing valve caps should be replaced immediately. In an ideal world, tyre pressures would be checked once a week with a calibrated gauge. In reality, it is more likely to be once a month, but it should never be less frequent than that. Trailer tyre pressures should be checked as well as tractor units.

On-board air pressure monitoring systems are available, keeping a constant check on tyre pressures. They have wheel-mounted pressure sensors that use a radio transmitter to send a signal to a display unit on the dashboard. This will alert the driver if the pressure falls below a predetermined level.

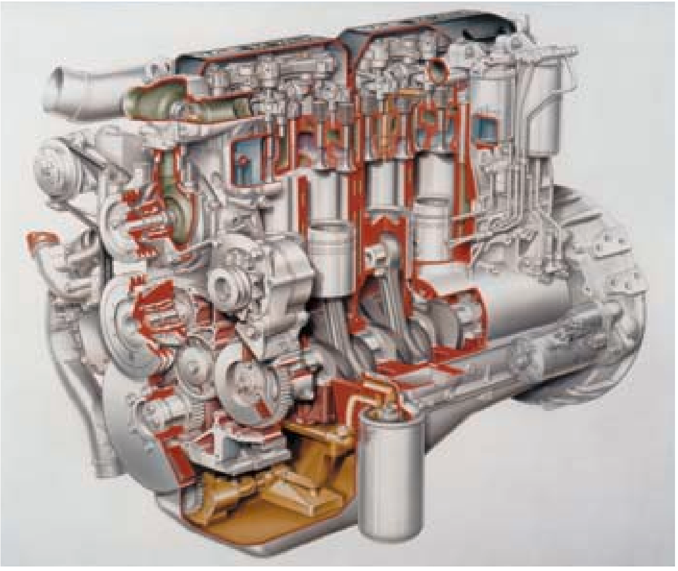
10.9 AXLE ALIGNMENT

Poorly aligned axles or incorrect toe-in/out on steer axles are normally associated with accelerated or uneven tyre wear, but as mentioned earlier, anything that hastens tyre wear is also likely to be harming the fuel consumption figure. If your workshop does not have its own equipment for checking axle alignment, specialist companies exist which can do the job for you.

Drivers should be required to look out for, and report, signs of the vehicle crabbing.

10.10 OIL AND LUBRICATION

Selecting an engine oil is an increasingly difficult task. Instead of just mineral oils, there is now an abundance of synthetic and semi-synthetic oils to choose from, and many claim to save fuel. However, decisions should be based on the official ACEA (Association des Constructeurs Européens d'Automobiles) grade specification of the oil and reference to the vehicle manufacturer's handbook.



The use of low-viscocity synthetic and semi-synthetic engine oils can improve an engine's fuel performance, but this should balance against the other technical and economic factors involved in a move away from a more conventional oil specification.

To achieve the ACEA grade (prefixed with an E for heavy duty diesel engine oils – E3, E4 etc.) the oil must pass a series of tests and so its performance has been measured. It would be wrong to choose an oil simply on its fuel-saving claims, particularly for modern engines that need to satisfy increasingly stringent European exhaust emission regulations (Euro-2, Euro-3 etc.).

The demands on engine oil are therefore becoming much tougher, and the ACEA tests include critical wear tests, ability to handle higher cylinder temperatures and soot dispersal capability. The long-term health of the engine has to take priority when selecting the oil, so following the vehicle or engine manufacturer's recommendations is always a sound strategy.

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Fuel saving claims in the region of three to five per cent for synthetic or semi-synthetic oils are commonplace. It is important to establish whether this is entirely derived from the engine oil, or whether the oil in the gearbox and drive axle has also been changed. It has been suggested that a two to three per cent saving is the maximum that can be expected from the engine oil alone. This has to be weighed against the higher cost of the oil. It might be worth swapping to a synthetic or semi-synthetic oil only in the gearbox or drive axle because the costs will be lower - there is less of it and it does not need changing so frequently, and it has been claimed that much of the savings will be derived from limiting synthetics/semi-synthetics to these areas only. Some commentators, (*Transport Engineer*, Sep 2000) have suggested that higher average speeds will reduce the impact on mpg.

One way to offset the cost of expensive engine oil is to make it last longer by extending the drain interval. Some of the most expensive synthetic oils are reportedly able to last up to 200,000 km in a light-duty application.

The vehicle or engine manufacturer will advise on varying the drain interval to suit the application, but the fuel consumption of the vehicle is usually a good indicator of the severity of its duty cycle. If the fuel consumption is better than average for the type of vehicle, the duty cycle is probably light and so it may be possible to extend the drain interval.

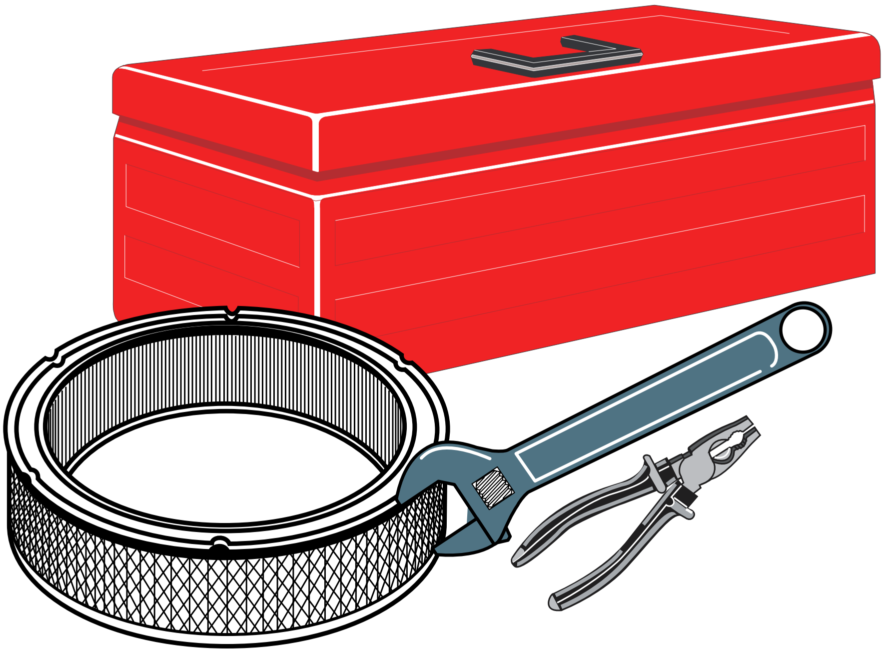
The best way of establishing the optimum engine oil drain interval is to use oil sample analysis. This is relatively inexpensive and not only determines the oil's life but also detects the various wear metals from the engine and the presence of water and fuel in the oil.

It is therefore a far more useful diagnostic tool than simply an oil life indicator. Analysis may suggest that you can extend the drain interval of your existing mineral-based engine oil. Many oil companies will offer a sample analysis service as part of an oil supply contract. There are also independent laboratories, which will give an objective, unbiased opinion.

When establishing an oil and lubrication strategy for the fleet, try to remain strictly objective about the costings. The value of reduced engine wear when the vehicle is seven years old is arguable if the vehicles are replaced after three years. Fuel savings have to be proved, not just claimed.

Remember to add the cost of top-up oil, and quantify the benefits of reduced downtime and longer oil filter life if the drain periods are extended. Finally, remember the environmental and financial costs of oil and filter disposal; doubling the drain interval will halve the amount of used oil and number of filters for disposal.

Checklist



Section	*Things to do*	*In place*	*Done*	*Not appropriate*
10.2	Maintenance department to: - Monitor fuel performance, trends and service records for evidence of poor driving habits/poorly performing vehicles			
10.2	- Monitor service records for evidence of poor driving habits	☐	☐	☐
10.3	Consider spot checks or outside auditors to ensure the quality of maintenance procedures and standards	☐	☐	☐
10.3	Monitor the balance between maintenance costs and fuel efficiency	☐	☐	☐
10.4/10.5/ 10.6	- Liaise with operational management to ensure they understand the need for driver disciplines associated with turbo chargers and other daily checks including checking for engine smoke	☐	☐	☐
10.7/10.9/ 10.10	Consider employing oil analysis, wheel alignment, engine performance checks and fuel injector recalibration	☐	☐	☐
10.8/10.9	Review tyre maintenance and axle alignment check procedures	☐	☐	☐

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11.1 INTRODUCTION

The driver is certainly at the heart of any fuel management programme, and success depends on his/her co-operation and commitment. So the object of this section is to devise a programme that gives the driver the best chance of success. This means involving the driver from the start and motivating him/her to do their best.

To develop a culture of fuel efficiency among drivers, treat them as a genuine partner in this programme. Senior drivers, shop stewards or a drivers' committee should be invited from the outset to contribute ideas. This will increase the chances of successful implementation.

A good relationship between the organisation and its drivers will help retain existing drivers and also attract better quality potential recruits. Some organisations have used long-term (five-year or more) programmes to encourage drivers to stay with them. This can be tied into schemes like the National Vocational Qualification (NVQ) scheme to give the driver some formal recognition of the skills attained.

The driver is at the heart of any fuel management programme. Money spent on training and developing your drivers can be an excellent investment.

11.2 RECRUITING FUEL EFFICIENT DRIVERS

When you recruit new drivers, you should ensure that all applicants are assessed, not only for their driving skills but also for their knowledge and ability to drive economically. There is a simple questionnaire about fuel efficiency for applicants in Appendix 11B at the end of this section. The questionnaire is also available on the disk provided.

You may wish to try this out on your existing drivers to test their knowledge base and identify any key areas for priority training.

In addition, there is a Fuel Savings Tips booklet available from the Helpline (Ref. RHMF001) or from any of the Fuel Economy Advisors contractors (see back cover). This booklet is aimed specifically at providing fuel efficiency information to drivers and owner drivers.

11.3 INDUCTION AND TRAINING

You should continue to stress the importance of fuel-efficient driving through induction and normal training activities. Drivers need to be aware of how to get the best out of the vehicle, what is expected from them and how well they are doing. They need to understand the disciplines that apply to them and why.

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11.4 COMMUNICATIONS PROGRAMME

Dialogue with all drivers is key, so a communication programme involving management, trade union (if appropriate) and drivers is an important part of any launch. This should explain the importance of fuel efficiency, and how drivers benefit as well as the company. The green benefits should also be included, but only if the company sees environmental issues as a genuine concern, rather than merely paying lip service.

Driving fuel-efficiently:

- is less stressful
- is less tiring
- is safer
- is more professional
- is greener
- saves money
- reduces wear and tear on vehicle

Be prepared for dissenting voices, particularly those who say that driving economically will slow them down and hamper productivity. Make them aware that the best drivers are safe, productive and economical. It is a measure of their professionalism - anyone can drive uneconomically.

11.5 PROVIDE FEEDBACK

Communication is a two-way process, so as well as providing feedback to drivers on fleet, vehicle and individual driver performance, ask for driver feedback and institute procedures to capture their ideas for improving the programme. Recognise and encourage their contribution of ideas.

11.6 CREATE LEAGUE TABLES

Publish a league table of fuel consumption figures. Ranking by driver is preferable, but if that is not possible, rank by vehicle and/or groups of drivers, or as a last resort, by depot. Select from the available ranking options those which best suit your operation.

Use league tables sensitively, recognising for example that some routes are tougher than others, and some vehicles are intrinsically less economical. Ultimately, you may be able to develop a handicapping system, which takes into account sufficient of the factors affecting fuel economy to make league tables more comparable.

Alternatively, create teams of drivers representative of the various sections.

The green markings on the rev counter are essential in helping the driver time his gear selection to keep the engine speed in the most fuel-efficient part of the range.

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11.7 TRAINING PLANS

A good-quality training plan is next. Whether you have your own driver trainers or buy in the expertise, you should make sure that the programme for drivers includes economical driving. Consider carefully who is trained first. Early positive feedback from opinion-formers can help enormously. The case study demonstrates the effect of good quality training on fuel performance.

You may wish to train your own trainers and get them to train the rest. Alternatively, you may wish to buy in outside expertise. Manufacturers may be able and willing to help either with training drivers or driver trainers. Obtain any videos from the manufacturers that you can. The video *Save it! - The road to fuel efficiency* (VI015) includes a section on driver training and the video *Save it! - Champions of fuel* (VI016) includes a section on safer driving techniques, both are available free of charge through the Helpline. Refer also to the manufacturer's handbook supplied with the vehicle.

Appendix 11E indicates the contents of a typical 'Training the Trainer' course. Training the driver can be 'on the job' or 'off the job'. Using on-board computers to provide driver feedback is very useful. (See Appendix 2 for a description.)

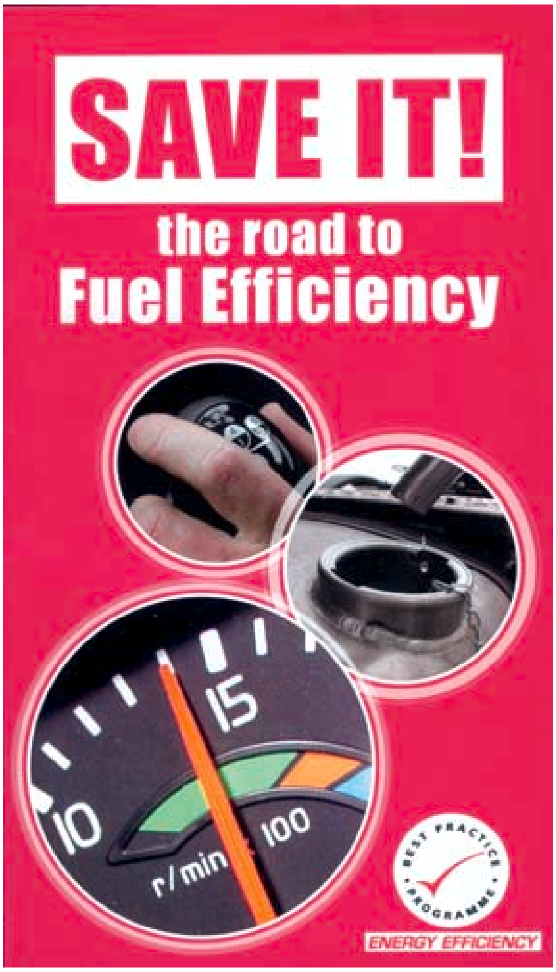
CASE STUDY

Benefits of driver training

One company introduced an in-house driver training programme for drivers to address a variety of safety and fuel economy issues.

The programme resulted in improved fuel efficiency, a reduction in environmental pollution, reduced maintenance costs and lower accident rates (See GPCS 311).

Speed and choice of gear ratios will influence the final fuel consumption figure. Speed limiters curtail only maximum road speed, so the driver has responsibility for using optimum engine speeds unless there is also a programme rev-limiter.



"Save It! The Road to Fuel Efficiency" is a training video available free of charge from the Helpline.

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11.8 DEVELOP THE DRIVERS

Develop your drivers by showing them how to get the best out of their vehicles.

Remind drivers that it is not only driving that needs to be economical. Their efforts must extend to other activities such as taking care to refuel vehicles consistently, reducing spillages at the pump, locking the fuel caps (if appropriate), ensuring the vehicle is free of defects and recording vehicle and mileage data accurately when dispensing fuel and completing records.

Publish data for drivers on the environmental impact of their improved driving performance. This can be achieved by expressing the reduction in fuel used per kilometre as a percentage. This also gives the percentage reduction in emissions.

11.9 DRIVER DISCIPLINES AND VEHICLE CHECKLISTS

Drivers should already do a safety check at the beginning of their shift or when they swap vehicles or trailers (see Section 10.5). Some examples of checklists, which include fuel efficiency issues, are included at the end of this section (see Appendix 11C).

Drivers should be encouraged to carry out a 'walk round' check of their vehicle at the end of every rest break they take.

There are also checks the driver should carry out from time to time when driving along the road - these should include:

- brakes binding;
- colour of exhaust;
- engine temperatures and oil pressures;
- air leaks.

Finally, since drivers are required by law to take mandatory breaks, at the end of these breaks, they can undertake a 'walk round check' of their vehicle checking for fuel leaks, oil leaks and air leaks as well as looking for obvious problems with the tyres.

11.10 SUSTAINABILITY

You need to have a plan for at least 12 months to sustain the programme - otherwise there is a huge danger of the programme simply petering out. Appendix 11A gives some ideas on what you could do.

11.11 FIT ALL VEHICLES WITH SPEED LIMITERS

Fit all vehicles with speed limiters, even those which do not legally require them. Choose the maximum speed carefully, paying regard to safety and legal limits. Reducing maximum speed has surprisingly little effect on average journey times, but can improve fuel consumption dramatically.

11.12 FIT ON-BOARD COMPUTERS

On-board computers can be fitted for a variety of purposes:

- training (should include fuel flow-meter);
- modifying driver behaviour (requires dashboard feedback device);
- monitoring individual driver performance;
- communications (needs modem);
- location tracking (requires global positioning system and modem);
- vehicle monitoring;
- setting optimum targets;
- assisting in evaluating fuel-saving interventions.

You may wish to consider fitting on-board computers to a small number of vehicles to establish the possible benefits.

11.13 ENCOURAGE DRIVERS TO MONITOR THEIR OWN PERFORMANCE

Provide systems to allow drivers to calculate their own performance. Normally drivers are expected to fill up their vehicles at the end of each shift. Driver worksheets can provide the formulae to calculate fuel economy:

Miles per gallon =

2.825 multiplied by **KILOMETRES** divided by **LITRES**

or

4.546 multiplied by **MILES** divided by **LITRES**

11.14 ONE PERSON RESPONSIBLE FOR FIGURES

Make one diplomatic front-line manager or supervisor responsible for monitoring results and discussing them with drivers.

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11.15 TACHOGRAPH ANALYSIS

Some operators have fitted 'RPM' versions of the standard tachograph. This is fitted with a fourth needle which records RPM on the reverse side of the tachograph and enables analysis of the driver's ability to keep the engine revs within the green band.

Others have fitted 'Dual Head' tachographs which record two charts, one for drivers' hours, the other for the Fuel Champion.

Specialist tachograph chart analysis can provide useful indicators of driver behaviour such as rapid breaking and overspeeding.

Analysis of ordinary tachograph charts can provide useful indications of poor driving behaviour.

11.16 AGENCY DRIVERS

Agency drivers play a significant role in many transport operations. It is beyond the scope of this Guide to deal with the subject of agency drivers in any great detail. However when reviewing this area, you should consider the following:

- do you have a policy on the use of agency drivers?
- is it operationally practical, and is it followed?
- does it include:
    - minimum experience?
    - training required for your business?
    - acceptable/unacceptable drivers?
    - agency driver performance?
    - basic brief to give to agency driver before he/she gets into the vehicle cab?

It may be that you can monitor the fuel performance of drivers from different agencies and use this in discussion with them.

APPENDIX 11.A SUSTAINABILITY

Here are some ideas for keeping fuel economy in the forefront of drivers' minds.

1 Competitions

Before considering competitions, you must have reliable and accurate systems to measure fuel performance at vehicle and driver level. Competitions can then be organised at whichever level you can monitor. Hence, if you can only measure at 'fleet' level, then you can reward only overall fleet improvement. But if you can measure at individual driver level, you can reward individual performance.

Competitions, if carefully constructed, can provide valuable incentives at relatively low cost and risk. They should be used sparingly to maintain their impact – two or three per year is about the maximum. The most important point is that all those whose behaviour you wish to influence should feel that they could win.

Hence merely rewarding the 'best' performance is likely to turn off those who consider they have little chance of winning. Other options include rewarding the most improved performance, or setting a threshold performance level which entitles all those exceeding it to participate in a prize draw.

Prizes should be carefully selected – often the best ones are activities that the winners would not normally arrange for themselves. Special interest 'day out' type prizes are popular. It may be that the drivers have a particular interest eg a charity to which the organisation could contribute, or perhaps they have been pressing for some benefit such as new lockers, which could be a suitable reward. Other options include shopping vouchers, vehicle models, driver's coats, etc

2 Bonus Schemes

Introducing a proper bonus scheme related to fuel consumption is a big step. It must be well thought through and take into account issues such as:

- different drivers doing different work;
- factors which will have an impact on performance including load, tractor/trailer configurations, weather, vehicle maintenance, type of roads etc.;
- impact on pay differentials.

It is clear that bonus schemes can easily become very complex, which goes against the central principle of good bonus schemes of simplicity. The more varied the work, the more complex the bonus scheme is likely to become.

This is a specialist area that can involve both significant cost and risk. You may wish to consider seeking specialist advice to tailor any bonus scheme to the particular requirements of the organisation. Some would argue that economical driving should be standard practice and so should not attract any special reward.

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3 *Themes*

You may wish to consider creating a 12-month plan of themes, with a different theme for each month. Two or three could be allocated to competitions that run for a month. In other months, the theme would be a key action to improve performance such as ‘Staying in the Green’ i.e. keeping the engine speed within the green band on the rev counter.

Other themes could be:

- idling;
- block-changing;
- driver disciplines;
- managing roundabouts.

Various ways of publicising the themes are available including driver briefings, printing the theme on timesheets, labels/stickers to go in cabs, posters, videos etc.

4 *Teams versus Individuals*

Consider putting drivers into teams for competitions. Teams should be evenly drawn from the operation and balanced so that they all start with the same average level of performance.

Apart from the benefits of getting teammates to help each other, it also helps to reduce the problems of drivers doing different activities by evening out the work across the group.

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APPENDIX 11.B FUEL EFFICIENT DRIVING: DRIVERS' QUESTIONNAIRE

Please indicate whether the following statements are true or untrue:

		True	*False*
1	Keeping the revs in the green band whenever possible improves fuel consumption.	☐	☐
2	The best way of deciding when to change gear is to listen to the engine noise.	☐	☐
3	Block changing (ie missing out gears) will not help your fuel economy.	☐	☐
4	Double de-clutching is good for the engine and fuel consumption.	☐	☐
5	The exhaust brake works best when the revs are low.	☐	☐
6	If the tyres are under-inflated, fuel consumption will be badly affected.	☐	☐
7	Carrying out pre-start checks is unnecessary and will not help fuel consumption.	☐	☐
8	The way the driver drives is not important in getting the best fuel consumption out of a vehicle.	☐	☐
9	Reducing fuel consumption helps to reduce pollution and therefore improve the environment.	☐	☐
10	If you know that the vehicle will be stationary for more than 2-3 minutes, you should switch the engine off to save fuel.	☐	☐
11	Driving at a steady 50 mph uses significantly less fuel than driving at 56 mph.	☐	☐
12	It is not possible to drive fuel-efficiently and defensively (or safely) at the same time.	☐	☐
13	The professional driver takes pride in driving safely, courteously and fuel-efficiently.	☐	☐
14	Although the principles are the same, you need to know the characteristics of the engine in each vehicle to get the best out of it.	☐	☐
15	You should always let the engine warm up fully before you start moving.	☐	☐

Answers:

1 True　2 False　3 False　4 False　5 False　6 True　7 False　8 False
9 True　10 True　11 True　12 False　13 True　14 True　15 False

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APPENDIX 11.C EXAMPLE CHECKLISTS FOR DRIVERS AND OTHERS

Checklist 1 – The Vehicle

1 Are the tyres in good condition and at the correct pressure?

2 Are the wheels correctly aligned?

3 Is the fuel system free from leaks?

4 Is the fuel system adjusted to the manufacturer's recommendations? Are the exhaust emissions visually normal? Black smoke indicates excess fuel.

5 Are the oil and coolant levels correct?

6 Is the oil of the minimum viscosity possible within the manufacturer's recommendations?

7 Are the air cleaners serviceable (ie not blocked)?

8 Is there any evidence of air leaks?

9 Is there any evidence of the brakes binding?

10 Is there any evidence of clutch slip?

Checklist 2 – The Operation

1 Are the speed limits being adhered to?

2 Is the engine stopped when parked or loading/unloading?

3 Are fuel purchases from outside sources kept to a minimum?

4 Is advantage being taken of the various fuel economy aids available?

5 Is the fuel consumption of the vehicle(s) monitored accurately?

6 Are the routing and scheduling arrangements designed to help fuel economy?

7 Are the drivers instructed in the optimum driving techniques for the vehicle in question?

Checklist 3 - Pre-start Checks

1 Fuel, coolant, oil, air leaks

2 Even tyre wear

3 Lock nuts and valve caps

4 Check the streamlining is correctly adjusted

5 Mirrors, lights

6 Properly adjusted seat, steering

7 Get in and out of the cab safely

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Checklist 4 - Running Checks - 'BACEE'

B Brakes not binding

A Axles and wheels properly aligned

C Clutch not slipping

E Exhaust not emitting black smoke

E Engine temperature and oil pressure

Checklist 5 - 'COBWEBS'

C Clean : Make sure lights and mirrors are CLEAN

O Oil: Check OIL and other fluid levels are correct

B Body: Check the BODY of the vehicle, the landing legs and the load

W Wheels: Check WHEELS, tyres, wheel nut indicators, lock nuts, valve caps and don't forget the fifth wheel

E Electrics: Check the ELECTRICS for loose wires etc

B Brakes: Check the BRAKES, including trailer brakes, suzie hoses, couplings, taps

S Stop: STOP and think, 'Am I fit?'

Checklist 6 - Keep Your Distance

1 Car - 'Only a fool breaks the two second rule'

2 Lorry - 'Know the score, make it four'

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APPENDIX 11.D COMMUNICATIONS

1 Introduction

If you want to get the maximum support for your fuel management programme, you must brief everyone properly. To be successful, all parts of the organisation must be aware and feel involved. It is therefore recommended that you publicise the programme as widely as you can.

It is beyond the scope of this Guide to discuss the various communication processes available. Instead, examples of the types of information which could be included in a brief are described. Obviously, this can be tailored to fit whichever methods are selected.

It is recommended that you read up further on this subject *Fuel savings tips* (RHMF001) - this handy pocket guide includes top tips on how to save fuel and money. It is aimed in particular at small-fleet operators and owner-drivers.

2 Possible Contents of Briefing

The following are some statements you may wish to include:

Driving fuel-efficiently:

- is less stressful;
- is less tiring;
- is safer;
- is more professional;
- is greener;
- saves money;
- reduces wear and tear on the vehicle.

On average, every time you use up a 400 litre tank of fuel, you produce:

- 1.04 tonnes of carbon dioxide;
- 1.38 kilograms of carbon monoxide;
- 0.67 kilograms of hydrocarbon;
- 6.15 kilograms of nitrogen oxide;
- 0.14 kilograms of particulates.

(Based on the typical Euro II specification engine in an HGV artic on motorway driving)

Source: UK Road Transport Emission Projections - 1997

Suggested drivers' brief

In the following, insert your own figures where indicated.

Currently the organisation uses xxxx litres of diesel per annum costing £xxxx. By saving 5% of the fuel we currently use, every year you will be reducing the company's fuel bill by £xxxx, and reducing emissions to the environment by xxx tonnes of carbon dioxide etc.

A vehicle that uses 30,000 litres of fuel in a year, produces 78 tonnes of carbon dioxide. If you improve your fuel consumption by 5%, you will put 3.9 tonnes of CO_2 less into the atmosphere in a year. (NB Use your own figures.)

The objective is not to try to teach drivers to drive, but more to help drivers to get the best out of each vehicle they drive.

For many years, fuel has been the fastest rising cost, usually going up above the rate of inflation. It is one of the largest costs. If you wish to remain competitive, you must do everything to minimise the amount of fuel you use. (NB Change this to match current fuel price trends.)

3 Conclusion

The above are some of the issues you may wish to raise. Don't forget to ensure you brief management (junior, middle and senior) and keep them advised of progress. The more publicity you generate, the greater the likelihood of success.

APPENDIX 11.E TRAINING THE TRAINERS

Aspects to be covered would include:

- basic training and coaching skills;
- driving the vehicle economically;
- selecting drivers for training and coaching;
- organising and implementing the training.

When considering the training needs of the trainer, take into account any training already undertaken.

Organising and implementing the training is an area which needs careful planning. Often operational priorities will conflict with training priorities – if it is a choice between training a driver and making an important delivery, then there really is little argument. However this can be very demotivating and lead to frustration for the trainer. It can also have a very negative effect on drivers who may perceive a lack of commitment to the training programme.

Try to avoid this by careful planning at the start of the training programme.

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Checklist

Section	*Things to do*	*In place*	*Done*	*Not appropriate*
11.2	Get all driver applicants to complete a 'fuel questionnaire' and read the Fuel Saving Tips booklet, available from the Helpline (RHMF001) or the FEA contractors.	☐	☐	☐
11.3/11.7	Ensure that induction and general driver training programmes include fuel-efficient driving	☐	☐	☐
11.4/11.6	Communicate well with drivers and transport management and publish league tables	☐	☐	☐
11.7	Obtain copies of driver training videos – '*Save It – The Road To Fuel Efficiency*' is available free of charge from the Helpline	☐	☐	☐
11.8/11.13	Develop and train your drivers in fuel management techniques	☐	☐	☐
11.9	Set up and implement appropriate driver disciplines and daily check routines	☐	☐	☐
11.10	Set up an ongoing, long term sustainability programme	☐	☐	☐
11.11	Consider fitting a tachometer (rev counter) to vehicles not already equipped	☐	☐	☐
11.12	Consider fitting one or two vehicles with on-board computers to monitor driver and vehicle behaviour/performance	☐	☐	☐
11.16	Review agency driver policy and how that fits into the fuel management programme	☐	☐	☐

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Appendix 1 - Fuel Measurement and Conversion Factors

1 INTRODUCTION

Fuel performance is usually measured in miles per gallon or litres per 100 kilometres, although kilometres per litre and miles per litre are also used.

Virtually all fuel-dispensing pumps measure in litres. Some electronic engine management systems can measure fuel used in US gallons. These are smaller than UK (or imperial) gallons. The exact conversion factor is included in the tables below.

Vehicles fitted with tachographs (generally those above 3.5 tonnes gvw) measure distance in kilometres, but buses, vans and cars more normally measure miles.

2 SOME BENCHMARK VALUES

Miles/gallon	litres/100 km
10 mpg	28.25 litres/100 km
9 mpg	31.4 litres/100 km
8 mpg	35.3 litres/100 km

Kilometres/litre	Miles/litre
3.54 km/litre	2.20 miles/litre
3.19 km/litre	1.98 miles/litre
2.83 km/litre	1.76 miles/litre

Miles per hour	km per hour
30 mph	48 kph
40 mph	64 kph
50 mph	80 kph
56 mph	90 kph
60 mph	97 kph

km per hour	Miles per hour
50 kph	31 mph
70 kph	44 mph
90 kph	56 mph
100 kph	62 mph
110 kph	68 mph

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3 CONVERSION FACTORS

To convert:	To:	Multiply by:
Miles	Kilometres	1.609344
Kilometres	Miles	0.621371
Litres	Gallons	0.21997
Gallons	Litres	4.54609
US Gallons	Imperial gallons	0.83268
Imperial gallons	US gallons	1.20094
Horsepower (bhp)	Kilowatts	0.746
Kilowatts	Horsepower	1.341
Imperial tons	Metric tonnes	1.016
Metric tonnes	Imperial tons	0.984

To convert from mpg to litres/100 kms and vice versa, use the following calculators:

$$\textbf{mpg} = \frac{\textbf{282.5}}{\textbf{Litres/100 km}}$$

$$\textbf{Litres/100 km} = \frac{\textbf{282.5}}{\textbf{mpg}}$$

If greater accuracy is required, replace 282.5 in the above calculators by:

282.4859

Drivers can use the following formulae to calculate their own mpg:

Fuel in:	Speedo in	mpg is given by
Litres	Kilometres	2.825 multiplied by kilometres divided by litres
Litres	Miles	4.546 multiplied by miles divided by litres
Gallons	Kilometres	0.621 multiplied by kilometres divided by gallons

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Appendix 2 - On-board Computers and Telematics

1 INTRODUCTION

The purpose of this Appendix is to act as an introduction to on-board computer systems as used in monitoring the performance of vehicles and drivers. Consequently, it does not cover the use of on-board systems for other purposes eg messaging and tracking. It does not include 'active' devices such as speed or engine rev limiters.

You should be aware that to get the best out of on-board computers it is important that the information they provide is acted upon, and drivers are well trained in their use and benefits.

There may also be additional benefits from fitting on-board computers unrelated to simple fuel management. Many organisations find that it is best to start with simple systems and add to them as they gain experience.

You may wish to consider trying out one or two vehicles with on-board computers to see the benefits for yourself.

This field is developing rapidly. Before deciding on any system it is worth canvassing a number of suppliers to check for the latest developments. It may be useful to read the Energy Efficiency Best Practice Programme Guide *Computerised routing and scheduling for efficient logistics* (GPG273), available from the Helpline and on-line from: www.energy-efficiency.gov.uk/transport

2 SOME TYPICAL SYSTEMS

The output from the simplest on-board computer system that does not include a fuel flow-meter can still be used to construct a league table of driver performance. The table is based on the principles of good driving that can be expected to improve fuel utilisation and reduce maintenance costs.

Typical factors detected and incorporated into the overall league table rating are the number of occurrences of harsh braking, periods of engine idling and time spent in the engine's green economy band.

The driver can be provided with feedback (displays, lights and/or buzzers) telling him when he/she is performing outside the pre-set standards, so he or she is receiving coaching to help move up the league table. Using a fuel flow-meter as one of the input devices adds the extra dimension of fuel measurement.

These more simple systems limit the number of input devices to around seven and have limited on-board memory. They are not intended to be heavily customised to a particular operator's needs, other than setting the various thresholds.

At the other end of the scale, the most sophisticated systems are more flexible and can deal with around 30 inputs if needed. They have a far larger on-board memory and need more powerful host computers back at base to handle the data.

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Driver performance monitoring is not the core function of these systems: they are normally chosen to give the driver facilities such as a keyboard for data entry and a printer for printing collection and delivery paperwork.

Truck manufacturers now offer some of the most extensive integrated on-board set-ups that build on the vehicle's own electronic engine management system.

They may combine the ability to monitor and download engine data such as coolant temperature, engine speed and fuel consumption with a host of other inputs such as axle weights or door openings.

Driver hours (picked up from the tachograph) can be incorporated, plus satellite tracking and even on-screen maps. Communication with base for data, speech or text messaging is included, so all the data can be downloaded (or uploaded) remotely.

The remainder of this Appendix describes the basics of on-board computers.

3 THE BASIC COMPONENTS

There are seven basic elements of an on-board (sometimes called 'in-cab') computer and/or telematic system:

- input devices;
- in-cab computer;
- in-cab communications device;
- driver identification device;
- download mechanism;
- host computer;
- database and reports.

Fig A3.1 shows their normal configuration:

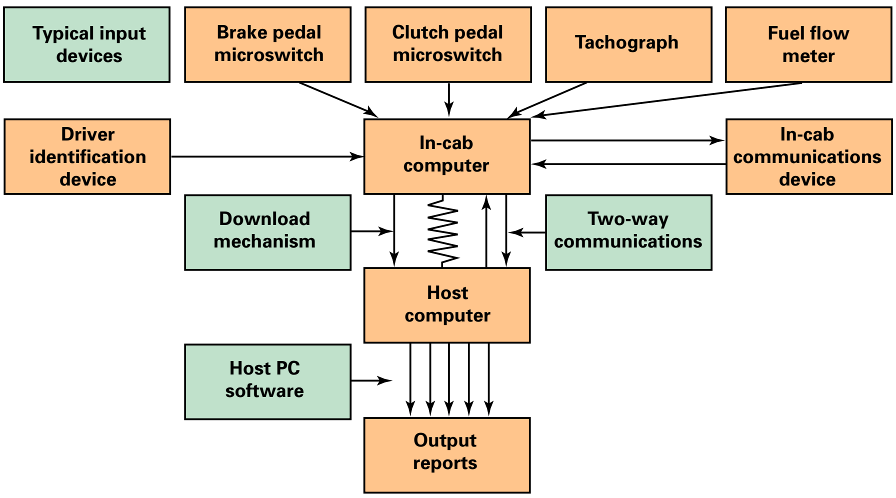

Fig A3.1 Configuration of an on-board computer

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4 INPUT DEVICES

There is a wide range of input devices that can be connected to the on-board computer. These include fuel flow meters, micro-switches attached to clutch, foot brake or exhaust brake, tachograph outputs, chill trailer temperature probes, GPS (global position system) location devices or monitors to record door openings. The main limitation is the number of devices that can be connected.

Most devices are universal and can be attached to different on-board computers. For example, fuel flow-meters are compatible with many in-cab computers. In other cases a computer interface programme may be needed to allow the input device to communicate with a particular type of on-board computer.

5 THE ON-BOARD COMPUTER

This receives data from the input devices, does the first stage of processing the information and then stores it for downloading. Different units will permit different numbers and types of input device to be connected.

They also vary in the amount of data they filter and process – too much filtering by the on-board computer restricts subsequent analysis.

Another point to check is the amount of data that the on-board computer can store. If it is small, it will limit the level of detail or the maximum period between downloads.

Because of these subtle differences between units that apparently do the same job, it is worthwhile making detailed comparisons and checking the suppliers' willingness to adapt the programming to your needs.

6 COMMUNICATION DEVICES

The simplest form of communication is where the on-board computer communicates with the driver via a warning light or sound. This may occur, for example, when a predetermined engine speed is exceeded.

The next step up also provides one-way communication to the driver, but uses a digital display to give information such as fuel consumption.

The two-way communication devices at the next level allow the driver to interact with the on-board computer, such as using it as an 'in-cab office'. These are capable of most functions of a normal PC including printing PODs (proofs of delivery).

The most sophisticated level takes in communication with the vehicle's base allowing not only downloading of data (see below) but true two-way communication, so that the base can send information to the vehicle and vice versa.

7 DRIVER IDENTIFICATION DEVICE

This allows the driver to log on to the on-board computer so that any information recorded can be reconciled to the individual driver as well as the vehicle – an important point in fuel management programmes, particularly if drivers are swapped between vehicles.

The identification device could be a data card, specific to the driver, which may also act as a download mechanism to transfer data from the in-cab computer to the host computer. Alternatively, the driver may have to identify himself by logging on to the on-board computer via a keypad.

In some cases, a completely separate device can be used. For example, each driver can be issued with a 'kiss key' that is touched against a sensor in the cab to log on.

The same key can also be used to transfer some of the information from the in-cab computer to other devices. It can trigger the depot's fuel pumps, automatically identifying vehicle, driver and transferring the tachograph's odometer reading.

8 DOWNLOAD MECHANISMS

There are a variety of ways to download the data from the in-cab computer to the host computer, including:

RS232 cable

This requires the in-cab computer to be connected by cable to an RS232 port on the host computer. Although cables of 100 m have been used, this method normally requires the vehicle-to-host computer cable to be no more than 20 m. Alternatively, a laptop computer can be taken to the vehicle.

RS232 portable download device

This operates in the same way as the cable except that the device acts as a portable temporary store. The data is downloaded via a cable to the device and is then uploaded via a cable to an RS232 port on the host computer. It solves the problem of long cable runs, without using a laptop computer.

Intelligent card

This has the dimensions of a thick credit card and can identify the driver as well as act as a portable download device. It is smaller and easier to use than the RS232 portable device but requires a card reader connected to the host computer. The process is relatively fast and requires the driver to withdraw the card from the in-cab computer and place it in the card reader.

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Radio transceiver download

This system allows the download of data from the in-cab computer to the host computer by radio transceiver, sited near a depot's entrance or the fuel island. The download of data is often organised to take place whilst the vehicle is fuelling up as some systems require the engine to be switched off before downloading can start. Other systems 'piggyback' off existing warehouse radio data systems, in which case the vehicle must pass within receiving range of the warehouse base station.

Mobile phone downloading

With this system, the on-board computer includes a mobile phone card and modem that allows the host computer at base to dial into the vehicle and retrieve the data.

Satellite downloading

This is normally the most expensive option and is generally mainly used for sending messages and tracking vehicles which are going to areas where GSM networks are not particularly reliable (eg Central and Eastern Europe). Because of the costs involved, it is unusual for satellite communication to be used for downloading performance information from on-board computers.

9 COMMUNICATIONS

Increasingly, communications systems are being provided by telematic systems. The vehicle download system must be either mobile phone or satellite and either communicates by messaging to a display on the vehicle, or removes the need for a separate mobile phone by 'connecting' a handset to the modem used to download the on-board computer.

10 HOST COMPUTER

A Windows® environment is usually needed to run the software on the host computer, although some run in a DOS environment. Some systems will not currently run under Windows NT®, while others require mini-computers rather than personal computers to operate the software.

11 DATABASE AND REPORTS

There is unlikely to be a shortage of data, and there is usually a wide choice of standard and customised reports. The main challenge will be picking the most appropriate reports that focus on the critical fuel management issues among all the data collected.

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